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UNIVERSITIES AND THE TRAINING OF TEACHERS

PART 3 of the Report on University Developments, which was adopted by the Council of the Association of University Teachers on May 25–26, 1945, and has now been published*, deals with two main topics: the universities and the education of teachers; and the international functions of a university. In regard to the former, the Association of University Teachers comes out emphatically in favour of placing the responsibility for the education and training of teachers in England on the universities. It will be recalled that while the McNair Committee recommended unanimously a similar course for Wales, that Committee was equally divided on the point in regard to England. Half the members, including the chairman, recommended a transformation or further development of the existing joint boards; the rest of the Committee recommended that each university should establish one or more schools of education, consisting of an organic federation of approved training institutions working in co-operation with other approved educational institutions, and responsible for the training and the assessment of the work of all students seeking recognition by the Ministry of Education as qualified teachers.

This principle is accepted by the Association of University Teachers, with the understanding that the scheme should be adapted to the needs of each particular region. Acceptance of this task is recommended for five reasons. The universities owe a duty to the society of which they are essential parts, and the education of teachers has long been one of their main functions. This work is vital to a civilized people, and by it the universities can make a contribution to the increase and diffusion of knowledge by raising the standards of teaching, and so aiding the maintenance of intellectual standards among the whole population. The universities are the highest stage in the series of educational institutions and should do all they can to strengthen the whole system. By accepting a greater responsibility for the education of teachers, they would make an effective contribution over the whole field of education. The universities have the prestige and ability to enable them to establish and maintain high standards, combined with freedom of development, in the education of teachers, without danger of the rigidity and uniformity which might characterize a single centralized body. Finally, the vitality of an educational system at all levels depends mainly on the teachers. It is much to be desired that all teachers should be members of a unified profession. The development of that unity among teachers in Great Britain has been hindered by the separation of those teachers who are preparing to teach young children from those who hope to teach in secondary schools and higher institutions. While it is not likely that the proportions of graduates teaching in secondary and primary schools will change, it is probable that

* Association of University Teachers. Report on University Developments. Part 3: Comprising the Education of Teachers: the International Functions of a University. Pp. 8. (Bristol: J. W. Arrowsmith, Ltd., 1945.) 1s.

bringing all the education and training of teachers under the ægis of the universities would do much to unite and raise the status of the whole of the teaching profession, and make possible a wider variety of training.

The Association of University Teachers does not discuss the counter-arguments put forward in the McNair Report, and the basic statement that "the fundamental studies and disciplines of all teachers, primary and secondary alike, are, at their apex, the concern of the universities", to quote a fine passage from the assenting group in the McNair Report, would have been stronger had this group, like Bruce Truscot in "Redbrick and these Vital Days", stayed to consider more fully the serious difficulty which the preponderance of students preparing themselves for one profession is bound to offer, especially in the arts faculties. The quantitative aspects are dismissed rather too lightly by the Association in the present report, and there is little real attempt to think out the implications and to see exactly where a principle, admittedly sound and desirable theoretically, will lead us. It is not sufficient to brush over the difficulty by the assertion that "the universities will not thereby be swamped by an excess of students of a single type", or that "Those who aim to become teachers are not for most of their university work, distinct from other students in many departments of the Faculties of Arts and Sciences", and "will thus contribute to the increase in the total number of university students which is to be expected".

The provision for this increase may be made either by increasing the size of some of the smaller university institutions or by establishing more universities, and the Association's report is right in urging that the chief obstacle to a large and rapid increase in student numbers is the difficulty of finding sufficient men and women to staff the universities on a proper standard. But this is largely beside the point. The danger of saturating a university with prospective teachers, with the risk that it may tend to deteriorate into a teacher-training establishment, will be far more acute than when it first aroused the concern of Flexner nearly two decades ago. Even when all allowance has been made for the expansion of the universities to provide the increased numbers of scientific workers and others required in industry and in the Government service for research and development, the annual influx of 10,000–15,000 recruits estimated as necessary to maintain the numbers of teachers who will be required to implement the proposals of the Education Act is far too large, in proportion to the most optimistic estimates for university expansion, to be dismissed without serious concern. Although it is apparently not the purpose of the Association of University Teachers at this stage to go into any details as to the ways by which this task may be accomplished, one might have expected some concrete evidence that a real attempt was being made to formulate constructive proposals for dealing with these dangers. Even more disturbing is the absence of any indication of the importance of the schools of education in regard to educational research, in spite of Sir Fred Clark's observation in this connexion in a speech on the university and the teaching profession at the Second Education Conference of the Association of University Professors and Lecturers of the Allied Countries in Great Britain in April 1944.

The risk may, of course, have to be run, and may be worth taking; but every effort should be made to keep the danger to a minimum. The Association in its report again pays very little attention to the suggestion for 'university schools of education', though such a development may make an important contribution. So, too, might any considerable increase in the intake of university graduates into business and commercial careers, and there are hints in the recent report of the Cambridge University Appointments Board which deserve further attention in this connexion also.

For the rest, the report urges that it is essential that the university should be responsible for the arrangement of curricula and the final assessment of university students. It endorses the recommendation of the McNair Report that the pledge committing students to teaching in consideration of receiving grants should be abolished, and that maintenance grants for students should be provided in such numbers as to ensure an adequate supply of recruits for the professions. The universities, moreover, could not accept the responsibility for the training of teachers without guarantee of the necessary financial resources, and these can only be supplied by the State. Again, graduate students in training should not relinquish contact with their academic studies, and the university should arrange for such students to continue academic work, both during their training-year and after entry into the profession.

Although the Association of University Teachers does not go quite so far as might be desired in the way of formal proposals, it nevertheless recognizes the undesirability of insisting on uniformity in organisation. It suggests indeed that each university, in its own area, should accept a similar responsibility to that of the present University of London Delegacy of Training Colleges, and receive the necessary powers for its execution; but a suitable scheme would have to be worked out for each region in agreement with other institutions concerned. Further, a university should be prepared to give advice to any student at any stage on the choice of his future profession. The location of training colleges and the delimitation of the area to be associated with each university institution is a matter for planning on a national scale in consultation with the universities. The alternative proposal of university schools of education is perhaps brushed rather too hastily aside, but we may nevertheless take the report as evidence that, so far as the teaching staff is concerned, the universities are more alive to their opportunities and more disposed to accept responsibilities which hitherto most of them have not desired. If the responsibility for training teachers be accepted by the universities, its adequate discharge must in itself place them in a far stronger position to make that contribution to regional life which Prof. Dobrée outlined in his Earl Grey Memorial Lecture nearly three years ago.

THE COPERNICAN REVOLUTION

Copernicus and his World

By Hermann Kesten. Translated by E. B. Ashton and Norbert Guterman. Pp. ix+408. (London: Martin Secker and Warburg, Ltd., 1945.) 21*s.* net.

"THE mightiest human in a thousand years was a Polish astronomer. Being fond of order, he began the fiercest revolution—that of science. Although he wrote about the moon and the stars, no man has dealt mankind and its false pride a heavier blow."

So begins the preface to the account of Copernicus and his world, written by Hermann Kesten, the German historian, novelist and playwright, who left Germany in 1933, became chief editor of the first anti-Nazi publishing house in Amsterdam, and then in 1940 settled in the United States.

Copernicus died on May 24, 1543. A copy of the book over which he had pondered so long, the publication of which had been delayed for so many years because of its possible consequences, was placed in his hands a few hours before his death, when he lay paralysed and unconscious. His last years were lonely; he had few friends; his housekeeper was driven from his home on some suspicion of scandal. His book was not a financial success; a few hundred copies were sold, but not many people studied it. Not until 1566 was a second edition published in Basle. When a third edition appeared in Amsterdam in 1617, the first edition had not been exhausted.

The Catholic Church at first ignored the book. It was not until 1615 that it was placed on the index, along with the works of Galileo. The Lutheran Church, distrustful of reform, was at first more vocal in its opposition to Copernicus and his theories. Luther said: "It says in the Holy Writ that Joshua bade the sun stand still, not the Earth". Melancthon was equally sweeping in his condemnation, and attempted to give physical arguments, such as this: "When a circle revolves, the centre remains unmoved; but the Earth is at the centre of the world, therefore it is unmoved". Calvin quoted Psalm 93, as a higher astronomical authority than Copernicus: "The world also is established, that it cannot be moved"; and asked: "Who will venture to place the authority of Copernicus above that of the Holy Spirit?" Even Rheticus, the enthusiastic disciple, whose "Narratio Prima" was the first account of the Copernican system and whose importunities at last caused Copernicus to yield and to agree to the publication of his work, in later years lost his early zeal. In 1564 he wrote to Ramus in Paris that "The shaky Ptolemaic theory must be replaced by the true and certain theory of the motions of the heavenly bodies, based on the obelisk that was used by the ancient Egyptians. Thus he would create a German astronomy for his Germans." An early foretaste of Nazi ideology?

The publication of this book follows closely upon the commemoration of the quatercentenary of the death of Copernicus. It gives a graphic account of the turbulent times in which Copernicus lived, of his life and of the people with whom he came into contact. Copernicus was a man of many parts: a wise administrator, a statesman, a soldier, a daring economist, a physician and always a friend of the poor. But mathematics and astronomy were his main interests. He was essentially not an observational astronomer, as might be inferred from this book. His instruments were primitive in design and construction, and his observations, mainly of eclipses or of oppositions of planets, were few and were made merely to enable him to re-determine some of the elements of the orbits. His work was done primarily in the study and not in the observatory. There, in opposition to all the thought and ideas of his age, he worked out his system which was to destroy the belief that the earth was the unmovable centre of the world. For some fifty years after his death, his work was neglected and his ideas scorned. But Kepler and Galileo defended the Copernican system, and through them the revolution in man's outlook upon the universe was accomplished.

The author states that at first only one man in Europe preached the Copernican revolution—Giordano Bruno, and that he was burned at the stake in Rome because the earth moved and he refused to keep silent about it. But this was not the only charge the Roman Inquisition had against Bruno: he was a runaway monk, a heretic who denied the doctrines of transubstantiation and of the immaculate conception; he was the author of the pamphlet "On the triumph of the Beast" directed against the Pope; and there were other charges. It is true that he upheld the Copernican system, that he considered that the universe was infinite and that the sun was only one star among many. Copernicus realized that, having reduced the stars to rest, it was no longer necessary to suppose that they are all at the same distance; but he regarded the question whether the universe had bounds or was infinite and without bounds as a philosophical one, which could not be tested by observation, and he therefore declined to commit himself. The first advocate of an infinite universe seems to have been the English mathematician and astronomer, Thomas Digges, who published in 1576, as a supplement to a revision of the work of his father, Leonard Digges, the "Prognostication Everlasting", an English translation of the principal chapters of Book 1 of "De Revolutionibus", with some paragraphs explaining his own ideas. This supplement was entitled "A Perfit Description of the Coelestiall Orbes, according to the most anciente doctrine of the Pythagoreans, lately reuiued by Copernicus and by Geometricall Demonstrations approued". It contains a diagram of the universe, based on that of Copernicus, but with the stars extending to the borders of the diagram, with the legend: "This orbe of Starres fixed infinitely vp extendeth hit self in altitude sphericallye, and therefore immovable; the pallace of ffelicitye garnished with perpetuall shininge glorious lightes innumerable, farr excellinge our Sonne both in quantitye and qualitye. . . ."

The "Perfit Description" had great influence on contemporary thought in England, going through at least seven editions, between 1576 and 1605. Bruno went to England in 1583 and published seven books, written in Italian, in London between 1583 and 1585. They sold badly and had no influence on English thought.

One of these books, "Dell infinito Universo et Mondi", containing his speculations on an infinite universe, may well have been prompted by Digges's work. Bruno's writings do not seem to have influenced either Kepler or Galileo; on the other hand, William Gilbert's attempt to give a physical explanation of the rotation of the earth through its magnetic properties, in his "De Magnete" (1600), was accepted both by Kepler and by Galileo. Gilbert, who was an advocate of the Copernican system, must have been familiar with the "Perfit Description".

The book is well written and of absorbing interest. It contains a fund of information, and its preparation must have involved a great amount of research. It is sometimes marred by overstatement, such as that Einstein, because of his theory, was expelled from Germany. It is the best and most complete account available in English of Copernicus, his work and his influence on human thought; it could with advantage have been provided with an index.

H. SPENCER JONES.

FORESTS AND FORESTRY IN GREAT BRITAIN

Forests and Forestry in Great Britain

By William Ling Taylor. Pp. x+172+21 plates. (London: Crosby Lockwood and Son, Ltd., 1945.) 12*s*. 6*d*. net.

MR. TAYLOR has had a varied experience in the Forestry Commission since its inauguration in 1920, and is now one of the forestry commissioners. In his preface he says that the book is written in the hope that it will serve to meet the need for a short outline of forest history and forestry in Great Britain, and the bearing that the national forestry policy will have on the future welfare of the British people. In brief, the book is written for the public, and although some technicalities have been unavoidable, it has no pretension to be a text-book. The contents show the author's intention, dealing with Britain's woods and trees; forestry in outline; land for new forests; forest making and forest mending; forests and perpetual profit; what forests produce; war in the woods; natural history of the woods; perils, pests and fire; forestry in the nation, and as a career; and does a timber famine threaten?

The treatment of some of these points may be briefly reviewed. In his chapter, "Forestry in Outline", in dealing with forestry education and what is required of the modern forest officer, the author is more academic than practical in his remarks. This is perhaps due to his own training. Whether the young forest officer is to serve in Great Britain, India or the Dominions or Colonies, the time available is sufficient to train the individual to become a good practical district forest officer. If he is to be utilized on specialized work such as estate management, the acquisition of land, to advise on legal matters or engage in specialized research work of any type, he should be earmarked for the work by his employer and afforded the necessary facilities to enable him to fill such a post. A sound training in forestry principles and allied science subjects fits the young man for taking up any post he may be appointed to. He has then, as in other professions, to learn the practices in force in his particular environment.

Mr. Taylor is on ground he well understands in his "Land for New Forests"—a chapter which may be recommended to all interested in this important matter; similarly, in the chapter on "Forest Making and Forest Mending", about which so much has been written, but the repetition of which in a book of this type occupies a necessary place. In his "Forests and Perpetual Profit" the author comes near writing a text-book chapter, for he discusses the methods of growing and thinning crops, and replacing them with the two-fold object of perpetuating both the forest and the yield. In "What Forests Produce", the utilization of various kinds of timber is dealt with in a broad general fashion.

"War in the Woods" is of interest in dealing with the heavy fellings made recently in private woodlands, though the Forestry Commission was able to afford some assistance also during the War. Much the same thing was written by authors after the First World War.

Apart from the remarks on the excessive danger to the new coniferous forests now growing up throughout Britain from fire, owing to railways, burning of heather or agricultural refuse, and the carelessness of the public, the other points of interest are the author's treatment of the natural history of the woods—ever a fascinating subject; the pests of trees, and the coming of the national forest parks. In conclusion, it may be said that Mr. Taylor has succeeded in one of his aims—producing a very readable book.

E. P. STEBBING.

SCIENTIFIC ACHIEVEMENT THROUGH THE AGES

Science, Past and Present

By Dr. F. Sherwood Taylor. Pp. viii + 275 + 22 plates. (London: William Heinemann, Ltd., 1945.) 10*s*. 6*d*. net.

AS its title indicates, this book covers a wide field of scientific achievement. The author describes it as "an attempt to show to the student the picture of science as an active growing organism". It is consonant with this aim that original work should be readily available, and this has been done by appending, to each of the eighteen chapters, a series of extracts from the writings of the period described. As may be expected, the author's wide knowledge of contemporary scientific literature is apparent in the interesting and useful selections which result.

The beginnings of science are traced from the earliest times, and extracts such as those from the "Rhind Mathematical Papyrus" and the "Edwin Smith Surgical Papyrus" illustrate the progress which had been made before the better-known Greek period. About a fifth of the book is devoted to science up to the Renaissance, so that ample space is available for tracing the foundation of modern theory and practice. At the end of Chapter 9, "The Age of Steam", two of the three extracts are from reports on the employment of children in mills and mines. These grim descriptions are followed by a chapter on "Science and Public Health". Geology, evolution and cosmology are appropriately treated, and a chapter is devoted to "The Age of Electricity". Among the many interesting references to modern medical practice is a case of myxœdema cured by gland-therapy.

The philosophical implications of science are not overlooked, particularly with regard to the concepts of physics. In the last chapter, "The Functions of Science", Dr. Sherwood Taylor maintains that "if man does not restrain the desire to destroy his fellowmen, science will enable him to gratify it with ever more appalling results". Any book which emphasizes the constructive, as opposed to the destructive, use of science is worthy of a wide public, and "Science, Past and Present" should appeal to all who are interested in the building of a better world.

The book is well illustrated with plates and line drawings, and a suitable reading list is appended.

H. D. ANTHONY.

Practical Optics

By B. K. Johnson. Pp. viii+190. (London: The Hatton Press, Ltd., 1945.) 15*s*. net.

THE publishers state that this book is intended to fill a gap existing among the books available for students and industrial physicists. In general, the subject-matter concerns the elements of optical instruments. Of the six chapters, the first three, entitled "Reflection and Refraction", "Focal Length Measurements" and "The Telescope", are mainly devoted to descriptions of experiments, illustrating simple instruments and measurements, to be carried out with spectacle lenses and small prisms. In all work of this kind an optical bench is needed, and the author recommends a steel metre rule set on its edge. In the chapters on "The Microscope" and "Photographic Lenses" less use is made of this method; in the latter, a historical account of the early development of photographic objectives is offered, with suggestions of methods for detecting defects in them, and in the former, magnification, resolution, numerical aperture and illumination are among the subjects considered. The final chapter, on "Optical Glass: its Working and Testing", contains a very short account of glass working, the measurement of refractive indices, curvature, and miscellaneous prism angles, and other workshop operations. The book contains several articles likely to be of interest to teachers of physics; but for the industrial physicist it will be found much less useful than the "Dictionary of Applied Physics", which points out the precautions needed to obtain accurate results. A few developments which have taken place since the "Dictionary" appeared are included in the present volume; but the treatment of them is much too brief to be of practical value. The author does not appear to be familiar with present-day practice and knowledge in some of the subjects he has treated. The mathematics is often badly set out and is not always correct, and a number of other errors have been noted.

The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms

A Colour Atlas and Guide. By Dr. T. Wallace. Supplement 1944. Pp. 9+48 (plates 115–209). (London: H.M. Stationery Office, 1944.) 5*s*. net.

MUCH attention has been given during the present century to the effect of mineral deficiencies on plant growth, and more recently it has become apparent that the presence of minute traces of new elements are of equal importance. This colour atlas deals with the visual diagnosis of deficiencies of those minerals which have long been known to be essential for plant growth; with the addition of a few trace elements such as boron, manganese and molybdenum, the importance of which has been discovered in more recent years. It forms a supplement to the original work on "Mineral Deficiencies in Plants", published in 1943.

The ninety-four colour plates are, in the main, of good quality and contain information regarding a number of additional crops including flax, broadbean, pea and red clover, lucerne, lettuce, radish, leek, celery, pear, plum and sweet cherry, and further deficiencies are illustrated for other crops already included in the main edition. The effect of nitrogen deficiency is shown for a number of crops, including wheat, flax, vegetable and fruit crops.

Very little is known yet concerning the function of the long-recognized essential elements which are required for plant growth. The discovery of a large number of trace elements which are necessary for normal growth of many species of higher plants and of fungi has raised new problems in plant nutrition, and in view of the continued need for a high level of production of home-produced foodstuffs it is essential that attention should be given to every factor that may reduce crop yield.

This Supplement and the original volume published in 1943 will serve to direct the attention of agriculturists and horticulturists to this important subject.

Annuaire astronomique et météorologique Camille Flammarion pour 1945

(81e année.) Pp. 382. (Paris: Ernest Flammarion, 1945.) 80 francs.

THIS volume opens with a short account of the life and work of Camille Flammarion (1842–1925), the founder of the *Annuaire*, and also contains a preface written by him. This 81st edition has been produced under many difficulties, among which are the restrictions on publications and the partial destruction of the printing establishment by bombardment, and the editor is to be congratulated on his perseverance in surmounting these obstacles. A short description of calendars of different races is followed by "Les Calendriers" for 1945, in which the festivals for various dates are given in three columns under the headings of Christian, Jewish and Mahommedan. G. Flammarion supplies a scheme of a perpetual calendar for every year in accordance with certain suggestions made in comparatively recent times regarding a reformed calendar. The co-ordinates of the sun and moon in right ascension and declination to the nearest minute of time and minute of arc respectively are supplied, together with the times of rising and setting at Paris, the sidereal time, and times of passage of the meridian of Paris. The usual planetary details are included and proper motions of stars, stellar spectra, double stars, variables, etc., are dealt with. Fourteen pages are devoted to problems connected with the physics of the earth, terrestrial magnetism, solar activity, magnetic storms, and also with climatology, including barometric pressure, temperature and rainfall. An index adds very much to the value of this publication.

M. D.

Experimental Electronics

By Prof. Ralph H. Müller, Assist. Prof. R. L. Garman and Assist. Prof. M. E. Droz. (Prentice-Hall Chemistry Series.) Pp. xv+330. (New York: Prentice-Hall, Inc.; London: George Allen and Unwin, Ltd., 1943.) 21*s*. net.

OF the many text-books introducing the subject of electronics, the one in hand, written by three chemists, approaches the matter entirely from the experimental angle. The extensive demand for this text indicates the success of this point of view; no student can, however, afford to neglect the more rigorous theoretical treatments in this field. In brief, the student is taken through many experiments on simple valves, photo-electric cells, and various multi-grid and gaseous tubes. Practical applications include D.C. and A.C. voltmeters, photo-tubes, and various types of amplifier and oscillator. Many references are given at the end of each chapter, together with relevant problems, the more interesting of which include applications to practical problems not discussed in the text.

L. E. C. HUGHES.

ATOMIC ENERGY AS A HUMAN ASSET*

By Prof. ARTHUR H. COMPTON
Chancellor, Washington University

THE ability to release atomic energy gives mankind great new powers. These powers can be used for good or ill. The first use of atomic energy was as a bomb the explosion of which stopped short a tragic war with the probable net saving of some millions of lives. Its terrific military destructiveness has made it necessary for us to consider afresh how we may avoid future wars. The dramatic demonstration of its explosive power has directed attention away from the significance of atomic energy to our industry, our habits of life and our culture. It is in such peace-time consequences that atomic energy will eventually mean most to man.

The atomic age has started as a period of keenest rivalry; a rivalry between nations and social systems. The prize to be won is prosperity and world leadership. It can include peace and security. If only we agree to place war beyond the power of nations, the race is sure to make life of greater value. Such is the prospect of a world strengthened by unlimited power from atomic fission and forced away from war by the examples of Hiroshima and Nagasaki.

The human consequences of the release of atomic energy can be considered in three major directions: first, its effect on war and the world's political structure; second, its application to the practical tasks of peace; third, its effect in changing the form of our social life and customs.

How Shall We Prevent Another War?

World government has become inevitable. The choice before us is whether this government will be agreed upon or whether we shall elect to fight a catastrophic third world war to determine who shall be master. Unity by agreement will bring greater life. Unity forced by another war will bring death to many millions and disaster to all mankind.

With regard to its economic and cultural life, the world has during the past century been developing into a unit in which the welfare of each person depends intimately upon that of the rest of humanity. Such development has not, however, resulted in political world unity. Now for self-preservation the great destructiveness of an atomic war, even to the victor, makes it necessary to ensure peace. In a quarrelsome world the only means of ensuring peace is to set up a world government which monopolizes the power to wage war. Thus it is that the new military developments culminating in the atomic bomb make inevitable a world government.

Now for the first time also it becomes feasible for a central authority to enforce peace throughout the world. Before the Second World War, many parts of the earth were difficult of access by a world police. To-day this is changed. Fast aeroplanes, long-range rockets and atomic bombs have now solved the technical problem of bringing to bear on any area at any time whatever destructive force may be required to quell resistance. A central authority having virtual monopoly of these major means of warfare can now be equipped to enforce international peace.

The fact is that the United States now has in its possession a sufficient monopoly of the weapons needed for such policing that it might be able to act in this capacity of world police. That Americans do not set themselves up as the world governors is simply because they do not want the job. They feel that world control is the world's business, not theirs alone. They know that if they used armed force to prevent other nations from fighting when American interests were not directly threatened they would be considered meddlers, and would gain only the fear and hate of other nations. America would prefer to withhold her fighting power unless her own safety is directly threatened, and confine her policing activity to her own reasonable share in keeping order within nations which are not now able to look after their own interests or which may become dangerous if not kept under control.

What is needed is an agreement which will make the safety of America much surer than could result from her own armed might, and which will at the same time provide for elimination of international wars elsewhere throughout the world. It is such an agreement that should be sought, sincerely, with determination, and with faith that it can be attained with reasonable promptness.

Other nations will not be prepared to challenge America with atomic weapons for the next five years. After twenty-five years, unless some mutual agreement prevents their development, such countries as Britain, the U.S.S.R. and France can arm themselves with weapons similar to those of the United States if they want to spend the necessary effort. The time required will not be greatly affected by whether America holds to her own secrets or not. It is in any event only a small part of the life-time of any nation that will elapse before the world may be faced with the awful possibility of an atomic war.

Now is the time when international agreements can best be made to prevent such a catastrophe. Other nations have not yet developed a pride in their atomic might which could give them dreams of world mastery. America's own effort has paid for itself many times over by stopping the course of the Second World War. All nations are now laying plans for the post-war years, and it will be much easier to shape these plans on the basis of world government than to stop the wild development of a renegade nation by imposing emergency military controls after it is set in its course.

It may be worth reviewing just what we mean when we refer to the great destructiveness of war in the age of atoms. For the first time in history it became impossible during the Second World War to protect one's home by holding the enemy beyond a wall or a fighting line. This change was brought about by armadas of aeroplanes guided by radar, jet-propelled aeroplanes travelling at almost the speed of sound, and long-range rocket bombs. What the atomic bomb added was merely a more efficient means of destroying a target. One aeroplane could now do the work that had required a thousand.

It must be remembered, on the other hand, that the atomic bomb is in its infancy. If the future demands it, science sees no reason to doubt that atomic weapons can be made that are related to the present atomic bomb much as the 'block buster' is to the blunderbus. Yet even the present atomic bomb is a highly effective weapon. If one bomb will devastate four square miles and damage a hundred square miles, how many bombs are needed to destroy the whole of a nation's concentrations of fighting and industrial facilities above ground? That is a question for the military

* Substance of an address before the American Philosophical Society and National Academy of Sciences on November 16, 1945.

authorities to answer. It has been demonstrated that whatever bombs are required can be produced and delivered to their targets.

Let us try to imagine what may be expected to happen if a war between two major powers should break out in 1970. We may assume that by this time both sides will have such weapons in whatever amount they consider necessary, and of greater destructiveness and variety than those now possessed by the United States. Because of the enormous advantage of surprise, Pearl Harbour tactics will be employed. Jet-propelled aeroplanes or rockets with atomic warheads will be sent without warning at each of several hundred of the enemy's major production centres. No city of more than a hundred thousand population will remain as an effective operating centre after the first hour of the war. At least ten per cent of the attacked nation's population will be wiped out in the initial blow. If this nation elects to fight back, rockets and aeroplanes from hidden installations will carry the reply. The attacker in this case can expect no mercy. Though his citizens may have immediately moved underground, his great cities as well as his surface production plants will be annihilated. The fighting will continue until one side chooses to surrender or is unable to resist its opponent's army of occupation.

No feasible means of preventing the bombs from striking their targets has yet appeared on the horizon. Only two countermeasures have so far been proposed. The first is to disperse cities, preferably into hilly regions, so that more bombs will be required to destroy them. The second is to place all military installations and essential industries underground, and provide emergency underground shelters for all the population. Clearly such measures will seriously interfere with the normal life of the community.

Is there then any procedure which can free us from the threat of annihilation? I believe there is. It makes, however, the hard demands of sacrifice of national sovereignty and of faith in other peoples that will give them a share in the responsibility for our own security.

Let us suppose that the United States, the U.S.S.R. and Britain agree to transfer their own total power to wage international war to a joint Military Commission. It will be better to include France and China as the other permanent members of the Security Council, so that the Military Commission can function within the framework of the United Nations Organisation. This Commission will have placed under its orders the united armies, navies and war weapons of the member nations. Its charter will give the Military Commission the responsibility for stopping any armed conflict between nations that may arise, including wars in which the member nations are themselves participants. This responsibility can be carried out since the major nations will have contributed to the Commission all their own fighting strength except that needed for their internal policing. To be effective it seems obvious that the actions of the Military Commission cannot be subject to the veto power of any single nation, but must be controlled by the joint action of some such group as the Security Council. For concreteness we may suggest further that this Commission have its seat in Canada, with its headquarters at either Ottawa or Vancouver. Canada will accordingly be the home-ground of the combined armies, the home waters of the combined navies, and in its vast territories will be dispersed the atomic weapons of the member nations ready for use in case of emergency.

As thus envisaged, the military strength of the Commission would be great enough to make hopeless the effort of any individual nation or group of nations to challenge its power. At first, all the strength in atomic weapons would be contributed by the United States. The other member nations would, however, contribute armies and aeroplanes and guns according to their proportionate share.

When the agreement is made to the satisfaction of the member nations, the details of producing atomic weapons would be passed on to the Commission which these nations entrust with their united military power. From then on there would be no reason why atomic bombs should be made by any other group, in the United States or in any other country. Nor is there any reason why, until such an agreement is reached, the technical secrets of atomic weapons should be released from the countries that now have them.

In the exploitation of the peace-time uses of atomic energy, each nation will need to give suitable assurance to the others that its own control of its atomic industry is such as to prevent the malevolent development of weapons by any group within its borders. It is essential that such assurance include provision for the inspection to any extent that may be necessary by representatives of the international Commission.

If the nations follow such a procedure with courage and determination, it would seem possible to ensure the banishment of international wars. It will then be possible to develop with assurance the peaceful fruits of atomic energy.

Two alternatives have been suggested to this idea of an armed international Commission. One is atomic disarmament. The other is maintaining American strength on a conclusively higher level than can be attained by any combination of other nations.

I am convinced that atomic disarmament would be a fatal mistake. An agreement to stop producing atomic bombs would only make it possible for some ambitious nation to develop them with the hope of gaining the mastery of the world, and the destruction of other nations would be the result.

For a number of years I believe the United States could as a nation maintain military strength greater than any group that might oppose her. Such a policy would, however, tend to unite the world against America, which would in the long run be disastrous. It is, furthermore, doubtful whether over some peaceful decades the United States would continue support of armed forces adequate to maintain a high level of superiority. She would then become vulnerable to the nation with the long-harboured grudge or the newly developed commercial rivalry. Even should she win, the next war would be disastrous.

The answer is rather to outlaw war itself. This can be done by a strong world 'police' which has at its disposal more powerful weapons than any recalcitrant nation can hope to acquire.

There is thus real hope that another atomic bomb may never be used in war, and thanks in part to atomic weapons that international war itself may already be obsolete.

Peacetime Implications of the Release of Atomic Energy

Enough regarding the destructive uses of atomic energy. Of much more interest is its use as man's willing servant. In the long run it can scarcely be questioned that the peaceful applications of atomic energy will be those that will most profoundly affect our lives. What these important applications will be

is, however, as difficult to predict as it would have been a century ago, just after Faraday laid the scientific basis for electrical engineering, to tell the future meaning of electricity. At this moment the obviously great field open to atomic energy is that of production of useful heat and power. We also see important though limited medical and industrial applications of radioactive materials, artificially produced by atomic chain-reactions. Perhaps more significant than either are the new vistas that will be opened up by scientific experiments that make use of the by-products of atomic fission.

This has indeed been the case with such discoveries as X-rays. Fifty years ago it was evident that X-rays were useful for 'seeing' through objects, such as the human body, which are opaque to ordinary light. It could not be predicted that X-rays would become a powerful weapon in the fight against cancer, or that researches made possible by X-rays would reveal the electron and with it give us the radio and a host of electronic devices.

Such unforeseen developments are the result of every great discovery of science. It will nevertheless be worth noting some of the definite practical applications of atomic energy that we can now see clearly before us.

At present, controlled atomic power in the form of heat is in continuous production in large quantities at several plants, especially those at Oak Ridge, Tennessee, and at Hanford, Washington. The heat from these plants is a by-product, and is carried away in one case by air and in the other by a stream of water. The useful product is neutrons, which are used in the plants as a means of transmuting certain chemical elements to others of specially useful characteristics. Of these transmutation processes the most important one is that of uranium into plutonium. Previous to the fission chain-reaction, the most abundant source of neutrons was the cyclotron, which operates on electric power. Per kilowatt of energy used, the fission chain-reaction gives some ten thousand times as many neutrons as a cyclotron, and it is not difficult to make a fission chain-reaction plant that delivers a hundred times as much power as is used by a cyclotron. This means that even now we are using large amounts of atomic power many times more efficiently for the particular process of producing neutrons than the best electrical machine that we have been able to devise.

Looking to the future, we may expect the use of neutrons as a means of producing new elements by transmutation to become of increasing importance. Plutonium is a concentrated source of available energy, and will be a valuable material for peaceful purposes as well as for building weapons.

Other artificially produced elements, especially radioactive ones, will also find use in medicine, in industry, and in many branches of science. It is yet too early to see clearly how important these uses may become.

We have not yet built an atomic power plant that is generating electrical power. This is merely because we have been engaged in winning a war, and there has been no serious shortage of electric power. If there were sufficient demand for a demonstration, a reasonably efficient plant using super-heated steam for driving a turbine could be put into operation within a year. Before, however, such plants can be made economical competitors with existing practice, a number of years development will be required.

While there are several other possibilities, the most obvious method of producing power from atomic fission is to heat a cooling agent such as air or steam or liquid metal in the chain-reactor unit, and pass this heated coolant through a heat exchanger which heats the steam for driving a turbine. Beyond the heat exchanger of such a plant everything would be done according to standard practice. Up to the heat exchanger all the design requires new features, among them protection against the extreme radioactivity of everything, including the coolant, that has been exposed to the neutrons.

The chain-reacting unit itself can assume many forms. The one essential is that it shall contain a fissionable substance such as uranium, either in its natural state, or if a small unit is desired, enriched with additional U^{235} or plutonium. H. D. Smyth, in his official report, has described in some detail how this active material can be combined with a moderator such as carbon or beryllium or heavy water so as to bring about the chain-reaction.

The large atomic-power plants now used for producing plutonium have in them many tons of natural uranium and graphite. By using uranium containing more than the usual fraction of U^{235}, chain-reacting units have been built that are of much smaller size.

There is, however, a lower limit to the size and weight of an atomic power plant that is imposed by the massive shield needed to prevent the neutrons and other dangerous radiations from getting out. Next to cosmic rays, these radiations are the most penetrating that we know, and for a plant designed to deliver, for example, no more than a hundred horse-power, are enormously more intense than the rays from a large supply of radium or an X-ray tube. To stop them, a shield equivalent in weight to at least 2–3 ft. of solid steel is needed. There are basic laws of physics that make it appear very unlikely that a lighter shield can be devised. This means that there is no reason for hoping that atomic power units for normal uses can be built that will weigh less than perhaps fifty tons. Driving motor-cars or aeroplanes of ordinary size by atomic power must thus be counted out.

Prominent among the advantages of atomic power are the extraordinarily low rate of fuel consumption and consequent low cost of fuel, the wide flexibility and easy control of the rate at which power is developed, and the complete absence at the power plant of smoke or noxious fumes. With regard to fuel consumption, when completely consumed, the fission energy available from a pound of uranium is equivalent to burning more than a thousand tons of coal. With the pre-war price of uranium oxide at roughly 3.00 dollars per pound and of coal at 3.00 dollars per ton, this would mean the economical use of uranium as fuel if only one part in a thousand of its available energy is used. Actually, we should expect the first plants built for producing atomic power to be considerably more efficient than this in their use of the fission energy, which would mean a substantial cost advantage in favour of uranium. One must consider also, however, the need to purify and fabricate the uranium into the desired form. For certain types of power plants under consideration, some separated U^{235} is required, and this is expensive. Attempting to consider all such factors, it appears that the fuel cost of the atomic power plant of the future will nevertheless be small as compared with the corresponding fuel cost of a coal-burning plant.

In considering the economic aspects, there are, however, many other factors. It is not really possible for these to be explored until we have actual experience with atomic power plants. First is the capital

cost. Clearly if one must charge against the capital cost what is spent in research and development, this cost is very high indeed. If, however, one looks down the line to a thousand million dollars a year national industry based on atomic power, the nation can afford a considerable investment in the research and development required to bring this industry into being. When this development is completed, it appears not unlikely that the cost of building and maintaining a large-scale atomic power plant may compare favourably with that of a coal-consuming plant of the same capacity.

Much remains to be learned, however, regarding the metallurgical and other technical problems involved in constructing a successful plant to transform fission energy efficiently into high-temperature heat. The materials to be used may be expensive. The designs are, nevertheless, essentially simple. An inherent advantage of the atomic power unit is that the heat sources, that is, the uranium blocks, can readily be maintained at any desired temperature regardless of how rapidly the heat is being removed. This means that a relatively small-size heater unit will be needed, and that corrosion due to excessive heating is controllable.

The terrific blasts produced by the atomic bombs have led to unwarranted fear of accidental explosions resulting from the normal use of atomic power. Explosions such as destroyed Hiroshima cannot occur accidentally. Such explosions must be carefully planned. The dangers of explosions of the 'boiler' type with an atomic power plant are about the same as with a steam plant, which is to say they are practically negligible if the plants are designed and handled by competent engineers.

There is, nevertheless, real possibility of damage to health of the operating personnel from rays emitted by the plant itself and by all materials that are taken out of the plant. These materials could also become a public hazard. This is the problem of the health of radium and X-ray workers on a grand scale. That the problem can be solved is shown by the fact that in all the operations of the existing half-dozen or more such plants, some of which have now been working for years, not a single serious exposure has occurred. This, however, is due to the thorough inspection and vigilant care given by the health staff headed by Dr. Robert Stone. In some of the experimental work we have not been so fortunate. Until we become much more familiar with nucleonics than we are at present, atomic power plants can be safely operated and serviced only with the help of health supervisors who are familiar with radiological hazards.

All this points toward using atomic power first in relatively large units where careful engineering and health supervision can be given. An obvious suggestion is its application to the power and heat supply of cities and of large industrial plants. Within ten years it is not unlikely that the power companies designing new plants for city service will be considering favourably the use of uranium instead of coal for purely economic reasons.

This, of course, does not mean that atomic power will put coal out of business. Each will have its own field. For small heating units, such as the kitchen stove, atomic power has no place. If our national economy grows as it should, coal as a chemical agent, as for example in blast furnaces and preparation of organic chemicals, will increase in importance.

From the point of view of the national economy the introduction of such a new source of power is a clear gain. If it will lessen the cost of heat and power to our cities, it will be a stimulus to every industry. If it reduces the pall of winter smoke, it will be a boon to all. If it gives cheap power where industry and agriculture need it but cannot now get it, it will extend the economic frontiers of any country. These are possibilities that lie immediately before us.

Atomic Energy and our Way of Life

Atomic energy is just one more step along the path of technological progress. It may, however, be the supreme gift of physical science to the modern age. Clearly its value will be determined by the use to which it is put. It is especially worthy of note that, along with other technical advances, the effect of atomic power is to force human society into new patterns. This need for human growth to meet the responsibility of atomic power is the basis of Norman Cousins' striking statement that "modern man is obsolete".

Let me note briefly three such effects of technology on society that can be clearly recognized. These are, first, toward greater *co-operation*, secondly, toward more *training and education*, and thirdly, toward evaluating one's life in terms of *service* rendered to the community. First, the society that is adapted for survival in the modern world is one in which an increasing degree of *co-operation* occurs between diverse groups spread over ever larger areas. As an example, consider the atomic bomb project, in which about a million people of all types and descriptions worked together to gain a needed result that could be achieved only by a great co-ordinated community.

In no field is the growing importance of such co-operation more evident than in that of scientific research. Faraday, a century ago, was one of the first professional scientists. Working by himself, he covered the whole field of electricity and much more besides. Sixty years ago, Thomas Edison organized what was perhaps the first research team to work with him at Menlo Park. Now America has thousands of research laboratories. From 1900 until 1940 her universities developed organized research groups for studying specific problems. Astronomers built specialized observatories. Research centres grew for studying diseases. Teams of physicists built cyclotrons and surveyed cosmic rays over the world. When the War came, co-operative research became of greatly increased size and effectiveness.

The development of the methods for producing plutonium is typical. At the peak there were engaged on this one problem roughly five thousand laboratory workers in seventy odd locations studying different aspects of this single problem. Not only theoretical physicists and nuclear chemists were needed; but equally vital were corrosion experts and metallurgists and hæmatologists and meteorologists, laboratory technicians, mechanics and office workers. No one person could be skilled in every field or understand even the meaning of the answers to the many problems. But somehow the group-mind integrates such knowledge into the useful form that results in a process that successfully produces plutonium.

There remains, happily, a valuable place for the individual research man who masters and advances his own limited field of study. His specialty, however, is of little value except as a part of a broader field. More and more we find that even in a limited field a team of men with different specialties working together does the most effective work. New thoughts develop in their discussions. More refined techniques

are available. A team which thus supplies a combination of originality and special skills is the pattern toward which research is moving.

Co-operation is the very life-blood of a society based on science and technology. Such a society is necessarily made up of specialists, not only men of science and engineers, but also skilled labourers, salesmen, administrators, educators, and legislators. Working alone, such specialists are useless. When their work is co-ordinated they form a society of enormous strength. What the society of an atomic age cannot permit is the development of antagonisms between these groups that will prevent effective co-operation. To love our neighbours is becoming the condition of survival; and our neighbours with whom we work are to be found in all divisions of society throughout the entire world.

As the second evident effect of technology on society, consider the need for ever-increasing training and education. It is no disparagement of engineers to point out that most of the new war-time developments that have led to Allied victory, such as radar, submarine detection, rockets, and the atomic bomb, have had to be led by men whose scientific knowledge is far in advance of that supplied by our technical schools and industries in the training of engineers. To compete in the modern world, more people need more training. Nor is technical training all that is required. Of greater importance is more education for leadership. In a democratic society that is forced into a position of world prominence, citizens as well as their leaders need to understand the problems and human needs of all the nations.

This pressure for more training and education applies at all levels. Automatic machinery performs an increasing number of routine jobs. The demand for skilled mechanics to make the machines is thus increasing while that for unskilled labour falls off. The growing complexity of society multiplies rapidly the demand for all kinds of persons trained to keep the work co-ordinated. These range from typists to administrators. Of those whose overall view of the needs of society is adequate to guide wisely an industry or the growth of a community there is an acute shortage.

The result is more students wanting more extensive education in schools and colleges. Professional schools are becoming graduate schools. More research men will need to carry their studies beyond the thesis for the doctorate. The interruption of college education during the War places a nation at a temporary disadvantage with regard to highly trained young men and women, and is for the moment keeping down the enrolment in advanced classes. All indications are, however, that the post-war pressure on the institutions of higher learning will increase and continue. There is growing interest likewise in all aspects of adult education as people strive to keep themselves abreast of the rapid changes of the times.

The third, and perhaps the most remarkable, trend is an increasing concern that one's activities shall *contribute to the welfare of society*. It is more difficult to establish this trend by citing examples than it is to show the increase of co-operation and of education. But it is, I believe, no less real. The ancient high regard for the 'holy man' who retired to a monastery and separated himself from society finds little sympathy in modern life. Reading of American colonial history shows that the freedom for which our forbears fought was primarily the right to live their own lives in the pursuit of happiness without unnecessary restrictions, not primarily the opportunity to shape a better society. Now both capital and labour strive to justify their position in terms of the usefulness of their contribution to society, and the United States have fought a war with unparalleled unanimity because loyalty to the common cause made her citizens ready for any sacrifice.

There have not been in the United States prominent movements similar to that in Germany, where the youth was whipped to patriotic ardour by the call to lose one's self in the greater good of the State. Nor has any 'cause' in America perhaps met with the wide response the Russians have given to communism as a political system, in which each person consciously works for the good of all. Yet Americans respond to many calls to service. As members of scientific societies we are aware of our own increasing attention during the past generation to the social responsibilities of science and scientists. The present active concern of men of science about the political disposition of the atomic energy problem is apparently only a representative example of the anxiety of every American that, with the great issues with which humanity is faced, his own actions may help rather than hinder a good solution. The greater powers placed in our hands by technology seem indeed to make us more acutely aware of our responsibility to use these powers for human ends that go beyond ourselves. Typical of the forces working in this direction is the recognized need that the democratic form of society must attain its fullest strength if it is to survive in the fierce competition of the post-war world.

The evolutionary law of the survival of the fittest applies to societies as well as to individuals. According to this law, the society of the future will inevitably advance along these lines of co-operativeness, of education, and of individual concern with service toward the common welfare. If selfish interests or an ill-adapted form of government should prevent the growth of one nation along these lines, some other nation or group that can develop thus more rapidly will pass it by.

These factors which give strength to society are precisely those that characterize the highest type of citizen. *Co-operation:* he likes to work with others on a common task. *Education:* he has learned to do his own useful task and to share intelligently in solving public problems. *Service:* the central objective of his life is to contribute to the common welfare the maximum that his abilities make possible. These also are the factors which make life of greatest value to the individual himself.

My point is that the release of atomic energy is merely the most recent important step of that steady progression of science that is compelling man to become human. He must pay careful attention to co-operation, education and service for the welfare of society if he is to thrive under the conditions that science imposes. If we will let ourselves grow as thus indicated, the civilization of the atomic age promises to be the richest that history has known, not only with regard to material bounty but also in its cultivation and appreciation of the truest human values.

How then are we justified in describing atomic energy as a human asset? First, atomic energy now supplies for the first time weapons which make it possible for a centralized world government to prevent wars between nations. Having made war intolerable because of its enormous destructive power, it thus opens the way for an international organisation to prevent war from ever occurring again.

Secondly, atomic energy is now a source of useful new materials produced by transmutation. It promises to supply us with heat and power, available in large quantities wherever needed, and thus to open new economic frontiers. New advances in medicine, in industry and in science are on the horizon.

Thirdly, as the most recent great step in the long progression of advances in science and technology, the advent of atomic energy is forcing mankind along the difficult road to greater humanity. Growing co-operation, education and spirit of service are evident trends.

In the fierce competition between social systems in the atomic age, the need for strength demands that we enable every citizen to contribute to the common welfare as his abilities may permit. Permanent peace can now be secured if we will work for it. Increased prosperity, with broader horizons, lies before us. Greater development of the human spirit is the inevitable consequence of the increased responsibility for using our new powers. These are among the greatest of human goods.

RADAR FOR CIVIL AVIATION

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THE story of the development of radar during the War is now well known—how it started as a defensive measure to give warning of the approach of enemy aircraft to the coasts of Britain, and grew finally to take an important offensive role in almost every form of warfare. An outline of the history of this remarkable development has been given in *Nature* by Sir Robert Watson-Watt*. One of the fields in which radar technique has made very large contributions is that of air navigation. In war-time, aircraft must fly in all kinds of weather, by day and by night, and the development of radio aids to replace those visual aids available in clear weather was of paramount importance. In peace-time it is just as important that aircraft should be able to fly with safety in all kinds of weather if aviation is to give regular and reliable passenger and freight service. It is still true, however, that the weather is the main limitation on flying, and although much has been accomplished, much remains to be done.

Advances made in war should become available at once for use in peace. It is therefore to be expected that radar should quickly begin to contribute towards safe and reliable civil aviation. That the immediate application of radar to civil flying has been slower than some would have hoped has been largely due to essential differences between civil and military flying. In order to understand the application of radar to the former, we must examine the most important of these differences. The most obvious difference is that of 'pay-load'. One may be prepared to spend a lot more to deliver a load of bombs on a vital objective than to deliver a load of passengers or freight. Again, one will be prepared to sacrifice a considerable portion of bomb-load for radio equipment if this will ensure that the remainder of the load falls on the target. In civil flying, however, weight and bulk of radio equipment must be kept to a minimum, otherwise flying will become uneconomic. Military aircraft must be able to navigate at will over most of the country at home and over enemy territory, expecting not co-operation but hostility over the latter. Civil aircraft are expected to keep rigidly to well-defined routes along which they can expect active co-operation from the ground most of the way.

It is not surprising then that much military equipment is not suitable for civil aviation. The fundamental scientific and technical principles learned during the War are, however, applicable, but some time must elapse before they can be used to create equipment specially designed for civil aviation. Nevertheless, there are several radar equipments in the navigational field which are immediately applicable to civil aviation and, if not now in ideal form, can at least be employed until more suitable versions are developed.

Advantages of Radar

It must not be supposed that only radar technique can provide answers to the problems of radio navigation. Indeed, in many cases ordinary continuous-wave (C.W.) techniques will provide a simpler solution than radar. Radar has, however, two outstanding characteristics which may enable it to succeed where continuous-wave technique would fail. The first is its ability to measure distance simply and accurately; and when this is required, radar has no serious competitor. The second arises through the fact that if short pulses are used, reflexions from the ionosphere and local objects near the transmitter may be separated from the direct pulses and so may be ignored. With continuous-wave systems, such reflexions frequently destroy the accuracy of the information obtainable from the system. Thus we shall see that for precise long-range navigation, radar techniques alone are likely to provide a satisfactory answer.

Radar Beacons

Very soon after radar had been developed for use in aircraft, mainly to detect ships (ASV) and hostile aircraft (AI), it was realized that by the use of repeaters to send back an amplified and coded form of the pulses received from the radar, an excellent navigational aid would be obtained. The radar set measures the range of the repeater, or 'responder beacon' as such devices are called, and by means of directional aerials enables the aircraft to home to it. This type of radar is known as secondary radar, primary radar being dependent on energy reflected from the target. When two beacons are within range, the aircraft may find its position by means of range cuts.

So successful was this form of navigation that it was desired to use it for aircraft which would not carry search radar. This is quite possible because the high-power transmitter of the search radar is unnecessary for navigation by responder beacons, since the 'echo' received is the retransmitted pulse from the responder and not the weak reflexion as from an aircraft or ship. Thus the radar beacon system of navigation was developed in its own right in the form known as *Rebecca-Eureka*. It became the basic radio aid for dropping paratroops, and its vital role on D-day has been told elsewhere. Thereafter a wide experience of the use of the system grew up in Transport Command and, as a result, its immediate application to civil aviation is possible.

One of the outstanding requirements for civil aviation is the measurement of distance along an air-route. The radar beacon system supplies this at once. In addition, homing to an airfield is simple and

* *Nature*, **156**, 319 (Sept. 15, 1945).

the facility is available for 'holding' a circular 'orbit' around the airfield while waiting to land. Since VE-day, a considerable amount of research has gone into adapting this system to the special needs of civil aviation. Cathode ray tube displays have been replaced by meters enabling the distance and orbiting information to be given direct to the pilot. Developments in miniature technique have been applied to produce a light and compact equipment.

Of all radar equipment, the interrogator and responder is the simplest and is likely to be the first to be widely used for civil aviation.

The scientific problems in this field are now well understood and there only remain the engineering problems of designing light and reliable equipment to meet the needs of civil aircraft.

Gee System

The need to develop a system of radio navigation to enable British bombers to operate at night over Germany became acute soon after it was apparent that our bomber offensive was likely to develop on a large scale. Out of this need grew the *Gee* system, perhaps the most extensively used of all radar equipments. Depending as the system does on the precise measurement of the time difference in the arrival of pulses sent out from three or more ground stations, *Gee* set a completely new standard of accuracy in radio navigation. In time, the whole of Britain and the surrounding sea was covered by the lattices laid down by several *Gee* chains, and although the coverage of enemy territory was seriously reduced by his jamming before we landed in Europe, large tracts of Europe are once again covered by *Gee* lattices. The system is such that any number of aircraft can use it, and the large raids staged by Bomber Command would have been impossible had *Gee* not been available to guide the bombers to their target and to get them back to their bases.

However, there are difficulties in using a system such as *Gee* for civil purposes. Large military aircraft carry a navigator who can take the *Gee* readings and plot his fixes. Civil aircraft plan to use as few members of crew as possible, and the desire is strongly expressed that all navigational aids should be presented direct to the pilot. Again, civil aircraft are required to fly along predetermined routes, and the navigational information should tell the pilot simply whether he is on the right or left of the track which he desires to fly. Undoubtedly electronic computers could be designed to enable *Gee* information to be presented in this form, but the system is already somewhat complex and this addition would almost certainly rule out its use for civil aviation.

In the meantime, however, owing to lack of suitable alternatives, it is likely that *Gee* will be used over large parts of Europe for a considerable time to come, even by civil aircraft. At present, the *Gee* ground stations each require a crew of two or three to keep them serviceable and in exact synchronization. Considerable steps have been made, however, towards making the synchronization completely automatic. In removing the need for large operating staffs, this would make the system more attractive for civil use.

Loran System

Loran, the American variant of the British *Gee* system, was developed principally as a long-range aid over sea. In order to achieve long ranges over sea, *Loran* uses the low 'high-frequency' band in the region of 2 Mc./s., whereas *Gee* works in the 'very high-frequency' band (20–80 Mc./s.), and so is limited in range, especially at low altitudes. All long-range aids previously developed had suffered from adverse effects due to reflexion of waves from the ionosphere. Since *Loran* is a pulse system depending, like *Gee*, on the timing of the arrival of pulses from ground transmitters, the ionospheric waves can be sorted out from the direct waves. Using the techniques of time measurement evolved in the process of radar development, a dependable accuracy is achievable at long range with *Loran* which is much higher than in any previous radio system. *Loran* is therefore likely to play an important part in trans-oceanic air navigation.

The equipment is unfortunately somewhat complex, but the facilities it gives are likely to justify its being carried by the large aircraft likely to operate on ocean crossings. There is no doubt that if an accuracy comparable with that given by stellar navigation under the best conditions is required at all times at long range, some pulse system like *Loran* must be used [see also p. 166 of this issue].

Ground Radar

Although it is an extremely attractive thought that the track of any aircraft approaching Britain may be plotted by means of the chain of radar stations, it must be appreciated that this involves a large and expensive organisation. Though this is justified in war-time, it is unlikely that civil aviation could afford to maintain its own complete radar cover. Such radar cover as is maintained by the military authorities would, of course, be available for civil purposes and would provide a valuable aid to aircraft in distress. One special application is, however, certain to be extensively used. In the vicinity of a busy airport, control of aircraft will normally be carried out visually. In dark or fog, however, this is impossible; but radar can supply the controller with much of the information he requires. Radar has, in fact, already been used for this purpose with some success.

Two outstanding problems require to be solved before full advantage may be taken of the facilities provided. It is well known that reflexions from fixed objects spoil the radar picture for the first few miles from the set. It is just those few miles that are most important for airfield control. This difficulty may be overcome to some extent by careful siting of the equipment, but this imposes severe limitations. The second outstanding difficulty is that of identifying each aircraft seen on the radar screen. There is little point in giving instructions to an aircraft if the controller does not know to which aircraft he is talking! Some progress has been made towards a solution of this problem by using direction-finding technique on speech from the aircraft, but this is unlikely to provide a satisfactory answer at busy airports. The ultimate solution is likely to be found through the use of secondary radar. By coding an airborne responder suitably, identity and other information such as altitude could be obtained. Trouble from reflexions from local objects could also be overcome as the responder normally is made to operate on a frequency slightly different from that used by the interrogating radar. The weakness of the system lies in the fact that aircraft would have to carry extra equipment which must be extremely reliable. The advantages to be gained, however, might well make this desirable, especially for scheduled aircraft. The main scientific and technical problems in this application are now well understood, and such a

system has been tried experimentally, including automatic decoding. The remaining problems are largely engineering.

An extremely high precision form of ground radar has been developed in the United States (*GCA*) and applied to landing of aircraft in conditions of poor visibility. The track of the aircraft, and also its altitude, are observed with high accuracy and the pilot is 'talked down' to the end of the runway by a controller. This system has the great advantage that no equipment other than a communication set is required in the aircraft. The ground equipment is, however, very complex, and this may limit its peace-time use.

Track Guides and Instrument Approach Systems

Existing continuous-wave systems used for track guides and instrument approach are not wholly satisfactory. If they are operated in the 'medium frequency' band, they suffer badly from static interference. If they are operated in the 'very high-frequency' band they suffer from site effects due to reflexions from local objects. This can only be overcome by clearing sites of all obstructions over a wide area. Airborne radar has been used during the War as an aid to landing military aircraft. The metric *AI* and *ASV* systems, as well as *Rebecca*, were operated in conjunction with special ground beacons which laid down an equisignal track (*BABS*).

The additional radar information given to the pilot in the form of his distance from the end of the runway proved of great value. The use of the system in its present form involves display on a cathode ray tube, and an operator must pass the information received to the pilot by voice. The transformation of the radar landing information to a form suitable for meter display as required by civil aviation has been achieved experimentally, but is much more difficult than the meter display of distance or homing information. The resulting equipment is so complex that it cannot compete with continuous-wave systems, in which the information is readily applicable to meters. Nevertheless, ultimately one may be forced to a pulse technique in order to overcome siting troubles, which are a very serious weakness in all continuous-wave systems in use.

The need for radio ranges laying down a multiplicity of tracks radiating from a centre has increased the troubles due to site obstructions. One of the first new problems tackled by radar research workers in Great Britain specially for civil aviation was the provision of such a 'multi-directional range' using radar techniques. Experimental systems have already been demonstrated, and it has been shown that excellent straight courses can be laid down using very short pulses even when no special precautions have been taken to clear the site. The same technique may ultimately solve the problem of laying down landing beams free from bends due to siting troubles. Much research, however, still remains to be done.

Airborne Microwave Radar

One of the most interesting and spectacular radar developments has been the use of centimetre wavelengths to produce in an aircraft a radar map or plan of the terrain over which the aircraft is flying (H_2S). With present technique the map is somewhat of a skeleton, only the main features such as towns, lakes and large rivers standing out clearly. It is not, however, unreasonable to assume that with further advances in technique, more and more detail will be discernible. At first sight this would seem to offer the ideal radio aid to navigation, being a direct replacement for contact flying and requiring no ground organisation. At the present moment, however, the equipment is heavy and complex and is mainly carried in heavy bombers. The major part played in the bombing operations by the Allied air forces by this equipment is now well known. It seems unlikely, however, that there will be any immediate application to civil aviation, as the weight and cost would be prohibitive.

Nevertheless, considerable advances in the technique of miniaturization have been made and it is not unreasonable to hope that equipment of this type weighing about 100 lb. will be possible in the not very distant future. Even so, it is unlikely that any but very large civil aircraft would be justified in carrying it. This field of research must, however, be one of the most important, for in addition to navigational information, microwave airborne radar may provide the solution to one of aviation's most pressing problems—warning of collisions.

Collision Warning

With the great increase in civil flying likely to take place, especially the increase in bad-weather flying, the danger of air collisions may grow to an alarming extent. Three types of collision are well known already, namely, collision with high ground, with dangerous clouds and with other aircraft. Undoubtedly, the danger will be much less when accurate and simple air navigation is available to all aircraft flying in bad weather and direct control is exercised by means of radar in the vicinity of busy airports. The ultimate solution, however, is likely to be found in equipment carried by the aircraft itself.

Warning of high ground and dangerous cloud is already well known to those who have operated microwave equipment in the air. There is still, however, much to learn about the reflexion of centimetric radio waves from clouds and rain. Interesting new data have recently been obtained, and it seems that radar may make a significant contribution to the understanding of the formation of rain clouds and other atmospheric phenomena. A great deal of design work on the display of warning information to the pilot has still to be done. The fact that echoes are seen on a cathode ray tube is but a first step.

The problem of collision with other aircraft is much more complex. Warning of the approach of enemy fighters was obtained with the microwave equipment in use during the War, but it is a long way from that to giving the pilot such information on the position and course of aircraft with which he may collide, and only those, in such a way that he can take appropriate avoiding action in the very short time which would normally be available. Any device which gave warning of anything but potentially dangerous aircraft would be a menace and would needlessly worry and distract the pilot. Here then we have one of the most interesting but difficult radar problems. It is likely to need new technique and much ingenious invention for its solution.

There are many other unsolved problems, but enough has been said to show that there is still much scope for research in the field of radar, and that one of the most important and interesting applications of this still new technique will be to making civil flying safe and sure. British research has led in the radar field in war—it must not lag in the peace.

OBITUARY

Dr. E. F. Armstrong, F.R.S.

EDWARD FRANKLAND ARMSTRONG, eldest son of the late Prof. H. E. Armstrong, died at the age of sixty-seven on December 14, after a short illness. A student in his father's laboratory at the Central Technical College, South Kensington, and afterwards with Emil Fischer at Berlin, he became much interested in the constitution of glucosides and related hexose derivatives, and in enzyme action. Later, when he had entered chemical industry, he found contact with other fields of research and, while his first objects of study never lost their hold (his last publication on carbohydrate chemistry, a contribution on polysaccharides in the "Annual Review of Biochemistry", was in 1938), he was associated successively with work on fats, dyestuffs chemicals, industrial solvents, hydrogen and hydrogenation, gas and fuel. As time went on, his own contributions to research lessened and finally ceased, for his function became rather that of a stimulus to the investigations of others and, especially, that of a leader in chemical industry intimately concerned with the development and re-orientation of a number of undertakings in the period between the two world wars.

A survey of Armstrong's own researches shows that his work with E. Fischer led in 1901–2 to publications, still regarded as classical, on the selective hydrolysis of glucosides and the isomerism of their α- and β-forms. On returning to Britain, while he was Salter's research fellow at the Central Technical College during 1902–5, and for some years after when chief chemist to Huntley and Palmers, Reading, he was much occupied with the mode of action of different enzymes, partly in association with H. E. Armstrong, Caldwell, Horton and Keeble. An interesting discovery emerging from these studies was that the rate of enzyme action is not controlled simply by the concentration in solution of the compound or substrate undergoing change, but that in each successive equal interval of time the enzyme determines the change of the same amount of substrate—the action is of a 'zero', rather than a first, order. This work appeared in a number of papers in the *Proceedings of the Royal Society* during 1904–13.

When in 1914 Armstrong joined the firm of Joseph Crosfield and Sons, Ltd., Warrington (of which he became technical director in 1915), he was interested to find that I had also observed an action of 'zero' order in the hydrogenation of liquid fats in presence of nickel, and encouraged the development of this study, which was communicated in a series of papers on "Catalytic Action at Solid Surfaces" between 1919 and 1925. At the same time, with Allan, Moore and Clarke, he fostered more intensive study of the component acids of natural fats, which led to a number of papers which may be regarded as pointing the way to modern technique in this field, since much extended. In a notable address in 1924 as president of the Society of Chemical Industry, he stressed the relatively backward condition of fundamental fat-chemistry at that time and undoubtedly helped thereby to re-awaken academic interest in this subject. Thus his own researches led to definite and notable advances in knowledge of the sugars, the fats, and certain types of catalytic action.

Meanwhile, Armstrong became a prominent figure in chemical industry. After ten years as technical director at Crosfields, covering most of the war-period 1914–18 and the immediate post-war period, and the merging of this firm with Lever Brothers, Ltd., he was appointed managing director of British Dyestuffs Corporation, Ltd., and saw in turn its transformation into a constituent of Imperial Chemical Industries, Ltd. In 1928 he returned to London as a consultant and was associated with several important chemical industries, while during the Second World War he was scientific adviser to the Ministry of Home Security and, later, to the Ministry of Works. His widening acquaintance with many different aspects of chemical industry, coupled with his scientific ability and standing, won him recognition as an important figure in industrial chemistry. He gave, moreover, keen support to the societies concerned with the interests of chemistry. Thus, naturally, he was prominent in the counsels of the Society of Chemical Industry, of which he was president in 1923 and 1924, and in the last decade of his life he was closely connected with the Royal Society of Arts, in which, after occupying the presidential chair, he was chairman of Council at the time of his death. He had also been president of the Association of British Chemical Manufacturers, and chairman of the British Standards Institution and of the Industrial Congress of Scientific Management. His association with the more academic and professional chemical bodies was equally intimate, and he was a member of council, at different periods, of the Chemical Society and the Royal Institute of Chemistry, and during 1924–25 president of the British Association of Chemists. He was elected to the fellowship of the Royal Society in 1920, and served on its Council during 1941–42 and as a vice-president in 1942–43.

Armstrong was known widely as an effective speaker and writer. In 1910 his "Simple Carbohydrates and Glucosides" was published, a standard monograph which passed through several editions until, in 1931, the glucoside section was expanded into a separate volume, in joint authorship with his eldest son, Kenneth, another brilliant chemist in the Armstrong succession who, most unhappily, died in an Alpine accident a few years later. Readers of *Nature* will recall many articles and reviews contributed by E. F. Armstrong, characterized by graceful style together with a certain freshness of outlook, always constructive and not infrequently bringing novel points of view into the subject of discussion. He rendered good service to science, moreover, in many public lectures in which he ably expounded one or other aspect of industrial chemistry.

This sketch of E. F. Armstrong's scientific and industrial career may have illustrated the many-sidedness of his mind and activities, but fails to display the nature and warm vigour of his personal character. Tall and physically well developed, he combined the paternal Armstrong's independence in thought with friendly suavity in speech and action, a blend of attributes which enabled him to travel far along the difficult path of science in industry. H. E. Armstrong was a famed and redoubtable exponent of science in education; his son, E. F. Armstrong, will be remembered for equally ardent service in a different field. A man of science by family ties, by training and by conviction, he spent most of his life in furthering the permeation of the industrial world by scientific principles and methods.

T. P. HILDITCH.

NEWS and VIEWS

The Great Sunspot and Radio Transmissions

A GROUP of sunspots of exceptional size came over the eastern edge of the sun's disk on January 29 and passed central meridian on February 5–6 (when the group was about 33° north of the disk centre); it should pass around the western edge on February 11–12. As the group came fully into view, it was seen to consist of a giant single spot preceded by a large double spot, with a total area, corrected for foreshortening, of 4,900 millionths of the sun's hemisphere on February 1–2. It is unlikely, however, that this huge area will be maintained for long. In several respects, the present group resembles that of January 1926, which had a maximum area of 3,716 millionths and a mean area during the transit of the disk of 3,285 millionths—hitherto the largest group in the Greenwich records, that is, since 1875.

The association of the present great spot with a certain continuous radio phenomenon observed on short-wave radio transmission, as with a big sunspot in February 1942, has been commented upon by Sir Edward Appleton in a B.B.C. broadcast (see also *Nature*, Jan. 12, p. 47). In addition, the spot region (up to February 3) has provided a notable example of an intense solar flare observed in monochromatic light ($H\alpha$; in the H and K lines of the solar spectrum due to ionized calcium, or in a few other special lines) and a synchronous 'irruption' of the ionosphere producing a marked fade-out on short-wave radio transmission over channels in the earth's sunlit hemisphere. These dual phenomena occurred on February 2 between 9^h and 11^h G.M.T. The flare appeared over the following spot then in longitude 45° east of the central meridian. Had the flare occurred rather nearer the central meridian, the statistical conditions would have been more favourable for any corpuscular stream, ejected from the spot region at the time of the flare, to have encountered the earth and so produce a 'magnetic storm' about 20 hours after the flare (*Mon. Not. Roy. Ast. Soc.*, **103**, 253; 1943). The spot group, if it survives, should re-appear at the sun's east limb on February 26–27 and should reach central meridian about March 5.

Sedleian Professor of Natural Philosophy at Oxford: Prof. Sydney Chapman, F.R.S.

PROF. SYDNEY CHAPMAN, whose appointment as Sedleian professor of natural philosophy in the University of Oxford has just been announced, began his academic life as an engineer, taking first-class honours at Manchester in engineering in 1907; but then turned to mathematics and took first-class honours in 1908. He went to Trinity College, Cambridge, where he continued to read mathematics, and in 1910 was appointed a chief assistant at Greenwich Observatory. He was Smith's Prizeman in 1913 and was a fellow of Trinity during 1913–19, when he returned to Manchester as professor of mathematics. In 1924 he moved to London, being appointed chief professor of mathematics at the Imperial College. He was elected a fellow of the Royal Society in 1919, and he has also served as president of the Royal Meteorological Society, the Royal Astronomical Society and the London Mathematical Society. During the War he was engaged in work for the War Office and at present is chairman of the Meteorological Research Committee of the Air Ministry.

Prof. Chapman's earliest researches were concerned with certain problems in pure mathematics. He followed with important papers on the dynamical theory of gases, and he helped to isolate the phenomenon of thermal diffusion in gases. He also contributed theories of magnetic storms and of diurnal variations in the magnetic elements. Geophysical subjects have, in fact, always occupied a great part of his attention; geomagnetism has particularly interested him, his numerous papers culminating in his standard book on the subject in conjunction with Prof. Bartels. He has also published important papers on the ionization of the upper atmosphere by radiation and the formation of the ionosphere, the formation and vertical distribution of atmospheric ozone and the lunar diurnal variation of atmospheric pressure.

New York Academy of Sciences: Honorary Life Members

THE following have been elected to honorary life membership of the New York Academy of Sciences: Prof. J. N. Brönstedt, director of the Institute of Physical Chemistry, Bledgansvej, Copenhagen; Sir Jack Drummond, recently professor of biochemistry, University College, London, now director of scientific research at Messrs. Boots Pure Drug Co., Ltd.; Dr. P. Kapitza, director of the Institute of Physical Problems, Moscow; Prof. M. L. Oliphant, Poynting professor of physics, University of Birmingham; Prof. A. Szent-Györgyi, professor of medical and organic chemistry, University of Szeged; Prof. N. H. Swellengrebel, president of the Third International Congress on Malaria, Amsterdam, 1938; Prof. J. H. F. Umbgrove, professor of geology, Technische Hoogeschool, Delft; Dr. C. M. Wenyon, consultant in tropical medicine, Wellcome Research Institution.

A. Cressy Morrison Prize Awards for 1945

Two A. Cressy Morrison Prizes for 1945 have been awarded as follows: A prize of 200 dollars for the paper entitled "Electromesons", by John Archibald Wheeler, Princeton University, Princeton, New Jersey; a prize of 200 dollars for the paper entitled "Limitations of Optical Image Formation", by Max J. Herzberger, Eastman Kodak Research Laboratories, Rochester, New York. An honourable mention was awarded for the paper entitled "The Golgi Apparatus", by Leonard G. Worley, Department of Biology, Brooklyn College, New York. It is announced that Mr. Morrison has renewed his offer of two prizes of 200 dollars each to be competed for during the year 1946, for the two most acceptable papers in a field of science covered by the Academy or an affiliated society; these prizes are to be awarded in December 1946. Mr. Morrison has also offered a prize in astronomy for 1946, in renewal of those awarded in recent years, of 500 dollars for the paper adjudged by the Council of the Academy to be the most meritorious contribution on the subject of solar and stellar energy.

British Journal of Pharmacology and Chemotherapy

THE British Pharmacological Society proposes to establish a new journal with the above title, to be published by the British Medical Association. Pharmacology and chemotherapy are two aspects of the same subject, dealing with the action of drugs on man and other organisms. It is particularly concerned with new therapeutic discoveries. This subject is rapidly expanding, and the discovery of many new remedies has had a profound influence on the teaching and practice of medicine and has stimulated much new clinical investigation. Not only pharm-

acologists but also clinicians, chemists, biochemists, physicists, bacteriologists, pathologists and other biologists, working in both university and industrial laboratories, have contributed to these advances, but their work is scattered throughout numerous journals. The new journal will bring together work, in all these fields, which is concerned with the effects of chemical substances on animals, living tissues and their chemical systems. It will publish original work in all branches of pharmacology and experimental chemotherapy, including the biochemical and pathological aspects of this subject. Provision will also be made for shorter communications and for brief notes on technique.

The editorial board of the new journal is: Prof. J. H. Gaddum, professor of pharmacology, University of Edinburgh (chairman); Prof. J. H. Burn, professor of pharmacology, University of Oxford; Dr. F. Hawking, of the research staff of the Medical Research Council; Dr. H. R. Ing, reader in pharmacological chemistry, University of Oxford; Dr. N. Mutch, physician to Guy's Hospital; Dr. C. M. Scott, director of the Pharmacological Laboratories, Imperial Chemical Industries, Ltd.; Prof. F. R. Winton, professor of pharmacology, University of London; and the editor of the *British Medical Journal*. Papers intended for publication should be sent to Dr. H. R. Ing, Department of Pharmacology, Oxford. Each volume will consist of four quarterly parts and will cost 25*s*. Subscriptions, payable in advance, should be sent to the British Medical Association, B.M.A. House, Tavistock Square, London, W.C.1.

Organisation of Research in the United States

An open letter signed by the members of a committee supporting the Bush Report has been addressed to President Truman on pending legislation for Federal aid to science (*Science*, 102, 545, 1945). The letter indicates that the committee favours the Magnuson Bill and is opposed to the Kilgore Bill. It believes that the main responsibility for the programme should be placed in the hands of a national science or research board composed of laymen and scientific men appointed by the President solely on the basis of interest in, and capacity to promote, scientific research and education. The committee is emphatically opposed to the subordination of the board to a single director appointed by the President, as is done in the Kilgore Bill. The board should be responsible for the appointment of the chief administrative officer of the foundation and no *ex officio* members of other Government agencies should serve as active members of the board. The committee does not think that the board should undertake to control or co-ordinate all Government scientific activity, but that, given high standards and sound practice in scientific education and research, the proliferation of interests and activities, together with a high degree of institutional and individual freedom and responsibility, is desirable. It is considered that social sciences should be taken care of by a separate body, and the point of view expressed in this letter is endorsed on behalf of the combined executive committees of the Union of American Biological Societies and of the American Biological Society, in a note signed by Prof. Robert Chambers and Prof. J. S. Nicholas, the respective presidents, which indicate that, as biologists, they are keenly interested in realizing the contemplated plans to include the biological sciences in a division of basic science separate from medical research and public welfare.

Visual Education in China

The University of Nanking is contributing vitally to educational development in China in its Motion-Picture Department, now ten years old. The Department has provided a two-year college course in motion-picture and radio, now to be extended to a full four-year course—a most important step which incidentally has no counterpart in Great Britain. Graduates spread all over China, and some have been sent to study cinematography in the United States. The Department issues a monthly periodical, *Film and Radio*, containing both technical and general information and illustrations. It has provided an extensive programme of motion-picture and film-strip shows for war information, general education and instruction. Films from British, American and Canadian sources are used, but an increasing number are produced in China.

The figures are impressive. At Cheng-tu (to which the University evacuated) fortnightly open-air shows averaged audiences of 10,000 with a peak of 29,000. In 1944, a total of 826 shows were organised, the aggregate audiences being more than 800,000. Nearly 6,000 film-strips were shown to more than a million people during the first four months of 1945. Leading professors are contributing to a production programme of two educational film-strips a month. The film is now part of the communal and university life, and is extensively used by professors and students. Many organisations and war factories in the Cheng-tu area have benefited by the work of the Department. In the University itself, a projection room, dark room and studio are provided for the use of staff and students. It has planned to extend this pioneer work of administration, training and research to five other universities.

Animal Population Research in India

The problems of animal population and migration have aroused increasing interest of recent years, and in stressing the need of a central institute in India, Major Roonwal, assistant superintendent of the Zoological Survey, will have the sympathy of most naturalists (*Sci. and Culture*, 11, 10; 1945–46). Attention is directed to similar work in other countries, especially in the United States, with its Fish and Wild Life Service, and the U.S.S.R., where very extensive studies have been made on animal populations, those on mammals and insects being the most extensive. In the U.S.S.R. there is a tendency to seek for causes of fluctuation in climate, and experimental work on the American model is not much in vogue. British research on the subject has been largely centred at the Bureau of Animal Population, Oxford, under the direction of Mr. C. Elton. Its practical applications are of the highest value to agriculture, fisheries and public health. Plagues of insects and mammals, especially rodents, are familiar to agriculturists the world over, and even in normal times their depredations are enormous. Fisheries fluctuate from year to year, and up to now little is known of the factors which govern the natural periodic rhythms of fish populations.

Finally, mammals play an important part in the transmission of various diseases in India, one of the best-known examples being the relationship between rats and bubonic plague, and although there is some indication of short population rhythms in India, there have been no extensive studies such as those being carried on in the U.S.S.R. on the fluctuations of mouse-like rodents associated with plague. The

complexity of these problems demands the services of a team of workers, extending over many years, and can only be carried out with the aid of a central organisation, which should serve as a centre both for receiving questions and transmitting information. It is suggested that there should be established forthwith in India a central institute of animal population and migration, staffed by competent zoologists whose main function would be the study of vertebrate populations and migrations from all points of view.

Length of the Small Intestine

PROF. J. B. CLELAND, of the University of Adelaide, writes: "In *Nature* of March 17, 1945 (p. 327), the maximum length of the small intestine quoted is 28 ft. 4 in. In the *Medical Journal of Australia* of September 30, 1944 (p. 359), I have given the lengths of the small intestine (not including the duodenum) in a hundred post-mortems at Adelaide. The longest five, all being males, were 30 ft., 31 ft., 33 ft., 35 ft., and 37 ft.; the longest in a female subject was 29 ft."

Science and the Welfare of Mankind

A CONFERENCE on "Science and the Welfare of Mankind" will be held in the Beaver Hall, Garlick Hill, London, E.C.4, during February 15–17. The Conference is being organised by the Association of Scientific Workers in co-operation with the Association of University Teachers, the Institute of Professional Civil Servants and the British Association of Chemists. There will be an introductory session dealing with "Science and World Needs" (chairman, Sir Robert Robinson). The three following sessions will deal with: "The Implications of Recent Scientific Development" (chairman, Sir Richard Gregory); "The Responsibilities of Scientists to Modern Society" (chairman, Prof. A. V. Hill); "The Organisation of Science" (chairman, Sir Robert Watson-Watt). Among the speakers at the Conference will be Mr. Herbert Morrison, Prof. P. M. S. Blackett, Prof. M. L. Oliphant, Dr. H. L. Richardson, Prof. B. Farrington, Prof. J. D. Bernal, Mr. A. Horner, Dr. Julian Huxley and representative foreign men of science. The Conference will be summed up by Sir Robert Watson-Watt. Tickets for admission (2*s.* 6*d.* per session, 7*s.* 6*d.* for the whole Conference) and further information can be obtained from the Association of Scientific Workers, 15 Half Moon Street, London, W.1.

Summer School on Theoretical Physics in Industry

A SUMMER SCHOOL will be held in the H. H. Wills Physical Laboratory in co-operation with the Institute of Physics, during May 30–June 6. The subjects to be studied will cover the general field of conduction of electricity in non-metals and will include luminescence, dielectric phenomena and reactions in solids. The course is intended mainly for members of the research staffs of Government and industrial laboratories who are engaged on experimental research in these subjects. Further particulars may be obtained from the Director of the Department of Adult Education, University, Bristol, 8.

German Aeronautical Developments

WHEN an exhibition of German aircraft was held last autumn at the Royal Aircraft Establishment, Farnborough, the Minister of Aircraft Production, Mr. John Wilmot, was convinced that the display should also be made available to the general public as soon as possible, at a central site. As a result, an exhibition of German aeronautical developments will be held under the auspices of the Ministry of Education at the Science Museum, South Kensington, commencing February 14. The exhibition will be open on weekdays from 10 a.m. to 6 p.m., and Sundays from 2.30 p.m. to 6 p.m. for three months. The exhibits are selected from those shown at Farnborough. They comprise a number of typical German military aircraft, including a jet-propelled fighter, flying bomb, the gyro-kite for use with U-boats, a piloted V1, a V2-rocket and radio-controlled rocket weapons. The exhibition coincides with the post-war reopening of the Science Museum for, in addition, the museum also has a series of exhibitions relating to atomic energy, X-rays and the quartz crystal clock.

Announcements

DR. J. S. MITCHELL, of St. John's College, Cambridge, has been appointed to the newly established chair of radiotherapeutics in the University of Cambridge.

ACCORDING to *The Times* correspondent, the University of Berlin was formally reopened on January 29. All arrangements for the reopening, the appointment of staff, and examining the political antecedents of students were made under Russian supervision. There are about three thousand students in all, and there is a teaching staff of a hundred professors and about a hundred and fifty lecturers.

ELECTIONS to three Beit Fellowships for Scientific Research will take place on or about July 6. Candidates must be of European descent by both parents and hold a degree or equivalent qualifications of a university of the British Empire. The age limit is twenty-five. Forms of application (returnable before April 6) and all information may be obtained, by letter only, addressed to the Registrar, Imperial College, South Kensington, London, S.W.7.

THE Staveley Coal and Iron Co., Ltd., is establishing a Central Research Department, which will include the research activities of its subsidiary company, Bradley and Foster, Ltd., of Darlaston, in order to co-ordinate all its chemical and metallurgical research. The new Department will be located at Staveley Works, near Chesterfield, and will be known as the Staveley/Bradley Foster Research Department. Its principal object will be the intensification of research and development in all aspects of the manufacture of chemicals and iron and their utilization. Dr. J. H. Hurst, technical director of Bradley and Foster, Ltd., has been appointed director of research to the Staveley Co., and the new Department will be under his direction.

WE have received a pamphlet entitled "50 Years of Scientific Instrument Manufacture" from the Cambridge Instrument Co., Ltd., this being a reprint of an article in *Engineering* during May and June 1945. The book of twenty-six pages is fully illustrated and gives an interesting story of the development of this well-known firm since its foundation in 1895 by A. G. Dew-Smith and Horace Darwin, the various instruments for which it has become famous being described. There can be no doubt that the company has materially assisted research and the scientific control of industry by its products. Copies of the pamphlet can be obtained from the Publicity Department, Cambridge Instrument Co., Ltd., 13 Grosvenor Place, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Radio-Frequency Energy from the Sun

RADIO-FREQUENCY radiation in the ten-metre range of wave-lengths which appea. 1 to originate in the region of the Milky Way was reported by Jansky[1] in 1933. He observed no measurable effect from the sun, despite the fact that its thermal radiation immensely exceeds the total from all other stars, and deduced that this 'cosmic static' originated in interstellar space. Later observers, Reber[2] (2 metres), English Army observers[3] (5 metres) and Royal New Zealand Air Force radar personnel[4] (1·5 metres), have since reported small or large effects from the sun itself.

On October 3, 1945, this Laboratory initiated a series of observations on 1·5 metres from a 400-ft. hill overlooking the sea near Sydney. The equipment consisted of an array of forty half-wave dipoles with a plane reflector, connected to a receiver having a noise factor of 9 decibels and fitted with a square-law output meter. Since the aerial rotated about a vertical axis, we could only direct it to the sun near sunrise and sunset.

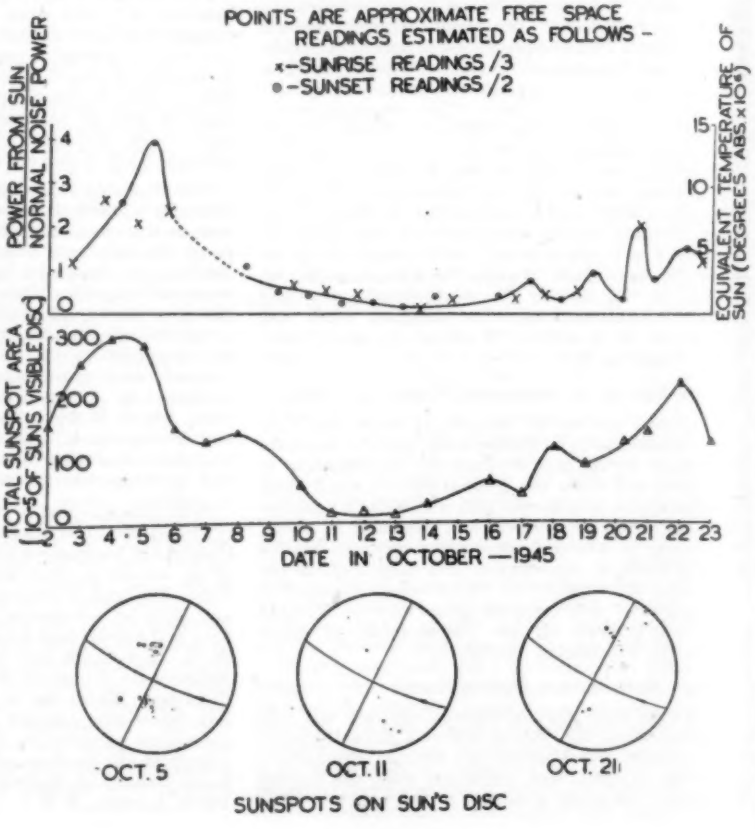
We observed, from the direction of the sun, a considerable amount of radiation having the apparent characteristics of fluctuation 'noise' when observed on a cathode-ray oscillograph or head-phones. However, the output meter reading fluctuated considerably, a characteristic which is not typical of normal thermal agitation 'noise'. The variation of apparent azimuth of arrival and of intensity with horizontal rotation of the aerial and the sun's elevation was qualitatively consistent with the assumption of radiation from the body of the sun modified by the known directional characteristics of the aerial.

The mean intensity for each observation during the period October 3–23, 1945, corrected as indicated for the effect of earth and sea reflexions, is shown in the upper graph. The ordinates on the left give the increase in receiver power output relative to the value when the aerial was directed away from the sun, while the ordinates on the right indicate 'equivalent temperature'. This is defined as the temperature of a black body of the same size and distance as the sun which would give the measured intensity of thermal radiation at the wave-length concerned (Planck's Law assumed).

Solar data obtained through the courtesy of Dr. C. W. Allen of the Mt. Stromlo Solar Physics Observatory, Canberra, are also shown for the same period. The middle curve shows the total sunspot area (estimated from pencil sketches) and the diagrams below show the appearance of the sun's disk on successive days.

It is apparent that the peaks of 1·5-metre radiation coincide with peaks of the sunspot area curve and with the passage of large sunspot groups across the meridian. This strongly indicates a physical relationship between the two phenomena, as suggested by the British Army observers[3]. Observations were also made at sunrise on October 4 and 5 on 50 cm. and 25 cm. equipment. On 50 cm. no effect was observed, indicating an 'equivalent temperature' of less than 50,000° K.; on 25 cm. a small effect was observed corresponding to about 6,000° K., the actual temperature of the sun.

In view of observations of such intense bursts of radiation from the sun at the wave-lengths at which 'cosmic static' is known, it appears desirable to question the suggestion that the latter originates in the interstellar space. It seems more reasonable to attribute it to similar bursts of radiation from stars which, because of their large number, could yield an approximately constant value for any one area in the sky. Furthermore, because of the very high levels relative to expected thermal radiation (a maxi-


POINTS ARE APPROXIMATE FREE SPACE
READINGS ESTIMATED AS FOLLOWS –
×–SUNRISE READINGS /3
•–SUNSET READINGS /2
POWER FROM SUN
NORMAL NOISE POWER
EQUIVALENT TEMPERATURE OF SUN (DEGREES ABS. ×10⁴)
TOTAL SUNSPOT AREA (10⁻⁶ OF SUN'S VISIBLE DISC)
DATE IN OCTOBER — 1945
OCT. 5
OCT. 11
OCT. 21
SUNSPOTS ON SUN'S DISC

mum equivalent temperature of more than 10^7 degrees in our case) and the observed short-period meter fluctuations, it seems improbable that the radiation should originate in atomic or molecular processes, but suggests an origin in gross electrical disturbances analogous to our thunderstorms.

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[1] Jansky, *Proc. Inst. Radio Eng.*, **21**, 1387 (1933).
[2] Reber, *Astrophys. J.*, 279 (Nov. 1944).
[3] Army Operational Research Group (British). Report No. 275. (Restricted report.)
[4] Alexander, Radio Development Laboratory Report No. RD. 1/518. (D.S.I.R., New Zealand.) (Restricted report.)

Long Duration of the Balmer Spectrum in Hydrogen

A recent paper published by Lord Rayleigh[1] under this title contains observations and measurements indicating a duration of the Balmer lines of more than 10^{-5} sec., that is, approximately a thousand times the duration found by experiments with positive rays[2] and also calculated from quantum mechanics. While earlier experiments[3] do not allow quantitative conclusions to be drawn, Lord Rayleigh's recent experiments must be regarded as being conclusive. The method mainly consists in producing in an electrodeless glass tube a strong luminosity of the Balmer spectrum induced by a powerful condenser discharge. Part of the gas is blown out of the electric field by thermal expansion into a side tube, where the luminosity extends a considerable distance outside the region of excitation and where the decay of the Balmer lines is observed and measured. Lord Rayleigh attempts no explanation of this apparent discrepancy; but especially asks for one. It may be appropriate and worth while, therefore, to point out that it seems to us that his experiments and similar ones can be understood on the basis of the known relatively long life of free hydrogen atoms and their re-excitation by radiation and especially by diffusing electrons and positive ions; also the recombination of positive ions (protons) may play some part[4].

The fact that hydrogen atoms 'live' relatively long in their normal state was discovered by Wood and studied in detail by Bonhoeffer[5]; it is explained by the theory of Born and Franck[6], who showed that the recombination of two atoms can occur only in a triple coincidence either with a third particle or with the walls of the vessel. In sufficiently wide vessels the life-time can be of the order of a few tenths of a second.

To explain the persistence of the luminosity, it is necessary to assume a re-excitation of the atoms in the ejected jet. There are no electric stray fields penetrating into the side tube in the present case, nor is the energy set free by the formation of hydrogen molecules sufficient to excite normal hydrogen atom. But the strong radiation from the main discharge[7] and diffusing electrons of sufficient energy can produce the excitation. The observed 'tapering' of the jet as it proceeds along the exit tube can be understood on the basis that the hydrogen atoms near the wall have a greater chance of hitting the wall than those near the centre, and therefore 'live' a shorter time. Incidentally, the fact that the blue-green H_β-line (4681 A.) alone is visible at the utmost end of the luminous tongue, whereas the red H_α- and the violet H_γ-line have died out, is probably due to the sensitivity of the eye, which has a maximum in the green part of the spectrum.

It may be possible to check the explanation given here for the observed long duration of the Balmer lines by special experiments.

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[1] *Proc. Roy. Soc.*, A, **183**, 26 (1944); see also *Nature*, **155**, 84 (1945), and Jablonski, A., *Nature*, **155**, 397 (1945).
[2] Wien, W., *Ann. Phys.*, **73**, 483 (1924); for a critical discussion of these and other experiments, see Mitchell, A. C. G., and Zemansky, M. W., "Resonance Radiation and Excited Atoms" (Cambridge, 1934), chap. 3, §3 and §7.
[3] Strutt, R. J., *Proc. Roy. Soc.*, A, **94**, 88 (1917).
[4] See Jablonski, A., *Nature*, **155**, 397 (1945).
[5] Bonhoeffer, K. F., *Phys. Chem.*, **113**, 199 (1924); **116**, 393 (1925); see also *Erg. d. exacten Naturwiss.*, **6**, 207 (1927), etc.
[6] Born, M., and Franck, J., *Z. Phys.*, **31**, 411 (1925).
[7] The subject of 'imprisoned' radiation in atomic gases and its re-absorption diffusion and 'persistence' is collected and discussed in Mitchell and Zemansky's "Resonance Radiation and Excited Atoms", chapters 3 and 4; the exact quantum mechanical theory of this subject has been worked out by E. A. Milne, *J. Lond. Math. Soc.*, 1, 1 (1926).

Halloysite-organic Complexes

I have recently directed attention[1] to the complexes which montmorillonite forms with polyhydric alcohols, a subject which has been further discussed in a paper by Bradley[2]. In these complexes, the alcohol takes the role of water in hydrated montmorillonite, and adsorption depends on polar forces (or secondary valences) only, not on base exchange. For this reason it seemed likely that similar complexes would be formed by halloysite, a clay mineral that is known to exist in hydrated and non-hydrated forms[3], but which has practically no base exchange capacity (that which exists being probably due only to surface adsorption).

The existence of such halloysite-organic complexes has now been confirmed. They are obtained from the hydrated form of halloysite by treating with certain alcohols in the cold, when the inter-layer water in the halloysite will be replaced by the alcohol. Some of the substances with which complexes have been obtained so far are listed in the accompanying table, together with the corresponding (001) spacing, as determined from measurement of the basal reflexion, and the degree of expansion as compared with the non-hydrated halloysite ('metahalloysite').

No.	Complex with	d (001)	Expansion compared with metahalloysite
1	Ethylene glycol	10·9 A.	3·5 A.
2	Glycerol	11·0 ,,	3·6 ,,
3	Trimethylene glycol ..	11·6 ,,	4·2 ,,
4	Ethylene chlorohydrin ..	10·8 ,,	3·4 ,,
5	Ethylene bromohydrin ..	diffuse	—
6	Methanol	10·6 A.	3·2 ,,

Most of these complexes have been obtained with each of four different samples of halloysite from Hungary, Eifel (Germany), Belgium and Lawrence County (Missouri). Some samples of kaolinite and one of anauxite have also been tried, but no complexes were obtained with these.

The amount of halloysite at my disposal was not sufficient to enable a determination of the water and alcohol contents to be made, and so a direct proof to be obtained of the replacement of the inter-layer water by the alcohol. However, there can be little doubt that in the case of complexes 1–4 this replacement is complete, because it has been verified that the complexes are not destroyed by keeping the alcohol-halloysite mixture at 100° C. for an hour. The hydrated halloysite is, of course, quite unstable at this temperature.

The adsorption of polyhydric alcohols by the metahalloysite has also been studied, as it was hoped that this might lead to a positive method for distinguishing between metahalloysite and kaolinite in clays—a matter which has caused considerable difficulty[4]. This aim has not been fully realized; but results of considerable interest have nevertheless been obtained. It was found that halloysite which has been gently dehydrated without heat (for example, over phosphorus pentoxide) will combine completely, or almost completely, with ethylene glycol, forming the 10·9 A. glycol-halloysite; at most a small residue may remain unattacked. From the glycol-halloysite, the hydrated halloysite may be regenerated by treating with an excess of cold water. Halloysite which has been dehydrated by heating to 75° for twelve hours was found, on the contrary, to be completely resistant to the glycol treatment. A natural metahalloysite from Missouri which was examined was found to be only partly susceptible to the glycol treatment, about 20–30 per cent remaining unaffected. Glycerol saturation of some metahalloysites has also been tried; but it proved less effective than glycol.

From these results it may be concluded that metahalloysite is not necessarily uniform, but may contain portions which are variously susceptible to attack by polar liquids. This may be due to variations in the degree of order with which the kaolinite sheets, of which the halloysite structure is supposed to be built up[5], are packed together. The degree of order presumably increases as a result of heat treatment; never approaching that of kaolinite, however, as is shown by the X-ray diagrams.

It will be seen that the glycol reaction may be of some use for the identification of halloysite in mixtures; a positive result points definitely to its presence, but a negative result does not allow any conclusions to be drawn.

From the chemical point of view the halloysite-organic complexes are interesting, because they open up a new field for the study of adsorption phenomena. Montmorillonite has already been widely used for this purpose[1,6]; the use of halloysite would enable some such phenomena to be studied under different conditions, and, in particular, without the added complication of the presence of base-exchange ions. An example of the sort of difference to be expected may be obtained by comparing my results for the (001) spacing of glycol- or glycerol-halloysites with the results given by Bradley[2] for the corresponding montmorillonite complexes. Clearly in the former there is room for only one (flat) layer of alcohol molecules between the halloysite sheets; whereas the montmorillonite complexes must contain two such layers, since the expansion of the (001) spacing is almost exactly double that for halloysite. This deduction as to the arrangement of the polyhydric alcohol molecules in the montmorillonite complexes was made by me on the above basis[7], and has been confirmed by the Fourier graphs shown in Bradley's recent paper[2].

A fuller account of the adsorption reactions of halloysite is in preparation. In conclusion, I must thank the following for gifts of material: the Trustees of the British Museum; the Grant Institute of Geology, Edinburgh; Dr. Lea, of the Building Research Station; and Dr. G. Nagelschmidt, of Rothamsted Experimental Station.

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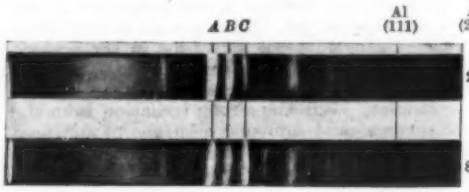
[1] MacEwan, D. M. C., *Nature*, **154**, 577 (1944).
[2] Bradley, W. F., *J. Amer. Chem. Soc.*, **67**, 975 (1945).
[3] See, for example, Hendricks, S. B., *Amer. Min.*, **23**, 295 (1938).
[4] Nagelschmidt, G., "The Mineralogy of Soil Colloids" (Tech. Comm. No. 42, Imperial Bureau of Soil Sci.), 12.
[5] Hendricks, S. B., *Amer. Min.*, **23**, 295 (1938).
[6] Giesecking, J. E., *Soil Sci.*, **47**, 1 (1939). Hendricks, S. B., *J. Phys. Chem.*, **45**, 65 (1941).
[7] Unpublished results.

Structure of Isoprene

A SHORT letter on an X-ray investigation of the structure of isoprene, chloroprene and butadiene at liquid air temperature was published in 1938[1], and a more detailed account of the work on butadiene has since been communicated to the Faraday Society[2]. It was pointed out that in the case of isoprene it was not found possible to get an X-ray diagram showing more than a broad liquid ring. In these experiments the isoprene did not appear to crystallize at all sharply, but solidified to a glassy mass. This may have been due to the impurity of the specimen. In the present case the isoprene was a very pure sample kindly prepared and purified for us by Dr. E. H. Farmer, of Imperial College.

A quite different X-ray technique has been employed in this work. The low-temperature camera, cooled by liquid hydrogen, has been described in some detail by Schallamach[3]. The evacuated cylindrical camera is built on to a specially constructed hydrogen liquefier. The vapour of the substance under investigation is admitted to a small inner vessel made of thin 'Perspex', concentric with the camera. Here the vapour crystallizes on to a thin aluminium rod which passes through to the liquid hydrogen. The temperature can be controlled and measured. The source of X-rays was a small demountable gas-tube with a copper anticathode. Exposure times were of the order of 15 minutes. From photographs taken at 20° K. and 80° K. it is immediately obvious that the substance was crystalline at both temperatures (see reproduction). The Al



lines from the central rod serve as a calibration for the film. An angle of 1° corresponds to about 2·1 mm. on the film.

The strongest lines are listed in the table below with the spacings calculated from the Bragg relation. As many as forty lines could be observed on some of the films, but these are not given owing to the inaccuracies of measurement.

It has not been possible to fit a unit cell to the data—it is certainly not cubic, but may be tetragonal (cf. butadiene). In comparing the photographs taken at the two temperatures it is at once evident that the structure is fundamentally the same in both cases, the same lines appearing on both diagrams, but there is a notable difference in the relative intensities of some of the lines. At 20° K. the line marked *A* is the strongest, then *B* and *C*; whereas at 80° K. the lines *A* and *C* are of almost equal intensity, while *B* is weaker than either. Although not consistently so, many of the spacings are slightly larger at the higher temperature.

	Isoprene 20° K.		Copper *K*α radiation 80° K.	
No. of line	Intensity	Spacing in A.	Intensity	Spacing in A.
1			ms	5·84
2	ms	5·73	ms	5·72
3	w	5·04	w	5·11
4	sss	4·34	ss	4·46 ?
5	ss	4·03	s	4·06
6	s	3·74	ss	3·76
7	ms	3·47	ms	3·48
8	w	2·96	w	2·99
9	w	2·92		
10	w	2·85		
11	m	2·81	m	2·82
12	m	2·78		
13	m	2·72	m	2·74
14	m	2·70		
15	m. diff.	2·60		
16	s	Al (111)	s	Al (111)
17	ww	2·17	ww	2·17
18	s	Al (200)	s	Al (200)
19	s	Al (220)	s	Al (220)

It was proposed to build a camera of much larger radius to enable more accurate measurements to be made on isoprene and other organic compounds, but owing to the War this work may not be resumed for some time.

We are indebted to Sir William Bragg and the managers of the Royal Institution for the facilities which they placed at our disposal.

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[*Publication deferred for security reasons.* Editors.]

[1] Clews, *Nature*, **141**, 513 (1938).
[2] Clews, *Trans. Far. Soc.*, **36**, 749 (1940).
[3] Schallamach, *Proc. Roy. Soc.*, *A*, **171**, 569 (1939).

Relationship between the Antigens of Blood and Skin

It is not possible to graft skin with permanent success between individual rabbits or individual human beings of ordinary genetic diversity. Skin so grafted is destroyed by a reaction conforming in broad outline to that of an active acquired immunity[1,2,3]. The red cells of 'transplanted' blood may likewise generate an active immune state, though in the familiar case of the *A*—*B*—*O* antigens of human beings the reacting system of antibodies is ready made, and not acquired in direct response to an antigenic stimulus.

The relationship between the immunological properties of blood and other tissue is not yet clear: strong circumstantial evidence for a close affinity between them[4] has been only once confirmed by critical direct experiments[5], and several times denied[6]. Two distinct questions require an answer: Does the transplantation of foreign homologous skin commonly result in the formation of red cell agglutinins? And does the transplantation of blood ever lead to immunity towards skin later grafted from the blood donor? Forty independent trials have given a uniformly negative answer to the first question. The second is more difficult to answer, because immunity to skin homografts is not yet recognizable by a test-tube or other *in vitro* reaction. It can, however, be recognized, in two numerically definable ways, by the modified behaviour of 'second-set' homografts, that is, of grafts transplanted to a recipient which has already been immunized by earlier grafting from the same donor source. The breakdown of such second-set grafts is greatly accelerated[1,2,3], and although they live for a few days in a condition of 'vegetative' survival, all nuclear division within them is brought to a complete standstill[2,7].

By applying these tests it has been found that four intravenous transfusions from one rabbit to another of 4 ml. whole blood fail to confer any degree of immunity towards skin later grafted from the blood donor. (Yet as little as 0·005 gm. skin may confer a complete skin immunity within sixteen days of grafting.) A more massive transfusion of whole blood, 12 ml. after each of six equally spaced intervals of time, produced a just perceptible immunity towards homologous grafted skin. The development of red cell agglutinins, when it occurred, was unrelated to the degree of mitotic inhibition. It is therefore likely, as the next experiments suggest, that leucocytes were responsible for the feeble immunity resulting from this more massive intravenous injection. For so few as three *intradermal* injections of a suspension in normal saline of the leucocytes of 4 ml. whole blood provoke a typical complete immunity towards skin later grafted from the donor of the blood to its recipient. One such injection alone produces a strongly marked but not complete immunity. Yet four intradermal injections of a saline suspension of pure red cells in approximately equal cell number were wholly ineffective. It has therefore been concluded: (*a*) that red cells and skin share at the most very few antigens between them; (*b*) that leucocytes create immunity to skin when grafted intradermally; and (*c*) that eighteen times the dose of leucocytes that is effective intradermally is barely effective when transfused intravenously. It follows that leucocytes share antigens in common with the antigens of skin. Here and above, by 'skin' is to be understood 'epidermal epithelium': the peculiar and quite distinct reactions of the dermal elements of skin[3] have not been taken into account.

The disparity of effective dosage recorded under item (*c*) may be of wider significance for the understanding of the immune reflex. It will be noticed, for example, that injection into a vein is made at the point farthest removed, in the physiological sense, from the lymph nodes. Intradermal injection gives the injected substance or the products of its inter-

action with tissue an almost direct access to them[6]. The superiority of the intradermal to the intravenous route is already known from studies on skin sensitization[8], with which transplantation immunity may be found to have something in common.

There is as yet no evidence that leucocytes play any practically important part in the reactions of blood transfusion, but the possibility that they may do so is obviously worth keeping in mind.

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[1] Gibson, T., and Medawar, P. B., *J. Anat., Lond.*, **77**, 299 (1943).
[2] Medawar, P. B., *J. Anat., Lond.*, **78**, 176 (1944).
[3] Medawar, P. B., *J. Anat., Lond.*, **79**, 157 (1945).
[4] Summarized by Medawar, P. B., *Bull. War. Med.*, **4**, 1 (1943).
[5] Gorer, P. A., *J. Path. Bact.*, **47**, 231 (1938).
[6] Haddow, A. M., *J. Path. Bact.*, **39**, 345 (1934). Kozelka, A. W., *Physiol. Zool.*, **6**, 159 (1933).
[7] Medawar, P. B., unpublished experiments.
[8] "Every intradermal injection is truly intralymphatic", McMaster, P. D., and Kidd, J. G., *J. Exp. Med.*, **66**, 73 (1937).
[9] See Landsteiner, K., "The Specificity of Serological Reactions" (Harvard, 1945).

Mutations in *Drosophila* after Chemical Treatment of Gonads *in vitro*

THE attempts to produce experimental mutations by chemical agents have hitherto been successful only to a small extent. The small effect may be due on one hand to the relative high chemical stability of genes and on the other to technical difficulties. The latter consist first of all in the fact that the methods usually applied do not bring the chemicals into direct and immediate contact with the germ-cells. If we feed chemical substances, we do not know what alterations in quantity and quality of the agent occur in the digestive tract and on the way from there to the gonads. Injection of the chemicals into the blood-stream or in the lymph is a better method; but here, too, we do not know how long the substance applied remains at work unchanged. Here a further difficulty consists in the fact that larger doses are often lethal for the treated animal.

In order to overcome these difficulties we have devised the following method. Gonads of a wild stock of *Drosophila melanogaster* are dissected from full-grown larvæ. They are then transferred for a definite period into an isotonic sodium chloride solution containing in addition other chemicals of known concentration. After this treatment the gonads are replaced in pure isotonic sodium chloride; and we then implant them in host larvæ of the same age, using the standard technique worked out by Ephrussi and Beadle[1]. Some of the implanted gonads become attached to the gonoducts of the host in place of one of the host glands. In this way it is possible to obtain offspring from the treated gonad, and since we use exclusively larvæ of a mutant genotype as hosts, we are able to distinguish between the offspring of the host and those of the implant.

The imagines derived from the treated gonads are inspected for possible dominant mutants and then used in crossing experiments in order to detect any recessive mutants. The *ClB*-method is applied for the *X*-chromosome (treated testes) and the *S/Cy*-method for the second chromosome (treated ovaries). Parallel to the experiments with chemicals we breed control series with material from the same wild stock. These controls are submitted to the same experimental procedure (dissecting, re-implantation, etc.) but without adding any chemicals to the salt solution during the period *in vitro*. In further controls, omitting the laborious process of implantation, we test our standard inbred stock merely for those mutations already present at the beginning of the experiment.

In the accompanying table we summarize some of the results of our experiments. Only data for recessive mutants of the second chromosome are considered.

Experiments	Number of tested second chromosomes	Number of mutations		
		visible	semi-lethal	lethal
Controls without implantation ..	126	—	—	—
Controls with implantation	124	—	—	—
Colchicine, 1 : 100,000 and 1 : 200,000; 15 minutes	70	—	—	—
Phenol, 1 : 10,000; 15–20 minutes ..	407	6	12	46

One of us (E. H.) first applied colchicine, in different concentrations ranging from 1 : 200,000 up to 1 : 1,000, testing it on ovaries. The gonads were, as a rule, left for fifteen minutes in the colchicine solution. It was found that concentrations of 1 : 5,000 and 1 : 1,000 kill the larval ovaries completely; in these cases nothing could be dissected from the host-flies. Weaker solutions (1 : 10,000 and 1 : 50,000) largely destroy the germ-cells: in no case were ripe eggs found. On the other hand, the developmental potencies of the somatic tissues of the treated ovaries remain more or less intact, as evidenced by their reaching the imaginal stage of differentiation within the host. Besides this tissue-specific action of colchicine there was another quite surprising effect: a relatively high percentage of the colchicine-sterilized ovaries showed a development of typical testicular sheet-cells on their surface. These cells are very flat, irregularly contoured, and contain the typical yellow pigment of wild type testes. This '*sex-reversal effect*' of colchicine will be described and discussed in a further paper.

Still weaker solutions (1 : 100,000 and 1 : 200,000) produce only a small percentage of completely sterile ovaries: a high percentage of the treated gonads produce ripe eggs, which, in those cases where the ovary becomes attached to the ducts, are laid in normal fashion. Thus we have the possibility of testing whether mutation is produced. However, the table shows that in no case was a recessive second-chromosome mutation found. The number of chromosomes tested is too small to establish any definitive conclusion, but our experiments at least show that colchicine cannot be regarded as an efficient agent in producing gene-mutations. This result is in accordance with the results obtained by Law[2] by injecting colchicine into *Drosophila* larvæ.

On the other hand, our method has achieved striking success with phenol (0·01 per cent solution). The mutation-rate obtained is very much higher than in any experiments with chemicals hitherto known to us*. For the present we have to refrain from calculating mutation-rates in percentages, since many of the mutated chromosomes arising from a single ovary may have all originated from a single

* Doubtless owing to difficulties of communication during the War, Drs. Hadorn and Niggli appear to be unaware of the work of C. Auerbach and J. M. Robson (*Nature*, **154**, 81; 1944), with a reference to an earlier note in 1943), who obtained even higher rates of mutation by exposure of *Drosophila* to allyl isothiocyanate (mustard oil). However, the method here described is novel, and should be applicable to a wider range of compounds than that of Auerbach and Robson. —EDITORS.

mutational event occurring in an oogonium still undergoing mitotic division: actually there is a relatively high intraovarial identity of the mutants so far tested by inter-crossing. Besides such intra-ovarial identity we have also found cases of inter-ovarially identical lethals. However, this result needs corroboration and amplification before any specific effect of the phenol on particular loci can be postulated.

Our method is capable of wide application. Large numbers of different chemicals should be tested, and concentration, time of treatment and temperature during treatment should be varied. The success obtained with phenol encourages us to hope that new information on the chemical nature and stability of genic structures will be obtained by further work on the present lines.

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[1] *Amer. Nat.*, **70** (1936).
[2] *Proc. U.S. Nat. Acad. Sci.*, **24** (1938).

Treatment of Agonal and Clinical Death

THE study of the pathophysiology and therapy of the state of agony during experiments on animals and, in more recent years, the study of these problems in man led us to the conclusion that arteriovenous transfusions of blood with a proportion of adrenaline and glucose accompanied by vigorous artificial respiration are the most important elements in the process of resuscitation.

We may now consider it established that death of an organism does not always occur as the sudden cessation of life. The state of biological and consequently irrevocable death is usually preceded by what is now known as clinical death, diagnosed as the cessation of cardiac and respiratory activity. This period of clinical death lasts only five to six minutes, and during this period the tissues and organs have not had sufficient time to undergo changes which cannot be reversed, and in which it is therefore still possible to restore the functions of the organism. Clinical death, therefore, is merely the qualitative expression of the process of dying; in a number of cases the transition from life to death can be checked in this period.

Whatever may be the cause of agonal and clinical death, weakening of the respiratory functions and blood circulation is a major pathological process of this period, which if allowed to develop leads to death of the whole organism. The process of dying taking place in the organism that is in the agonal state or in the state of clinical death can therefore only be checked and the development of the process averted by reversing these two cardinal functions.

We felt that the data we had obtained experimentally should be used to treat wounded soldiers who were dying from wounds; accordingly we went to the Front and there in the field dressing-stations commenced work.

The major points in our methods were intended to restore the activity of the blood circulatory system by means of arteriovenous transfusions and vigorous artificial respiration with the help of bellows.

Before introducing blood into the organism, it was heated in a bowl of hot water to 37–39° C. To the blood we added 1–2 c.c. of a 1 in 1,000 solution of adrenaline hydrochloride, and 50–100 c.c. of a 40 per cent solution of glucose. The brachial artery and vein were prepared for operation. A needle was inserted in the centripetal (with reference to heart) direction and blood was introduced at a pressure of 180–200 mm. of mercury.

As soon as there was strong contraction of the heart, blood was sent in the opposite direction, that is, transfusion was continued in the vein, this time under a pressure of 40–60 mm. Usually arterial transfusion of 200–300 c.c. of blood was sufficient to produce the necessary effect (restoration of coronary circulation). The quantity of blood introduced into the vein depended on the condition of the patient and varied from 500 c.c. to 100–200 c.c.

Artificial respiration was administered by means of bellows with a capacity of one and a half to two litres. At first, artificial respiration was given at the rate of 25–30 respirations a minute and then reduced to 16–20 a minute. The amount of air introduced at each respiration was shown on the scale of the bellows as 1,000–1,500 c.c. Artificial respiration had to be continued for some time after the appearance of natural breathing, although the rate was reduced and it was applied with intervals of rest.

A major indication for the use of this treatment is primarily sudden death from such causes as excessive loss of blood, suffocation agony and clinical death in cases of patients suffering from severe wounds to the limbs, collapse, etc. In the course of four months, we treated 51 cases of shock, agonal and pre-agonal and clinical death; there were 17 cases of bad shock, 20 cases of agony, 10 cases of clinical death and 4 cases of suffocation. In 34 cases out of 51, our treatment preceded proposed surgical operation, and thirty-one of the cases treated were able to undergo surgical treatment. The final results of our work were as follows: in 12 out of 51 cases, treatment produced a permanent effect in wounded men who had been regarded as hopeless and who were already in a state of agonal or clinical death. After resuscitation they were evacuated to hospitals in rear areas. In 37 other cases, the effect was not permanent, and wounded men died later as the result of the severe nature of their wounds. Among the cases of clinical death treated, five recovered completely all their functions. With one exception, we did not find any disturbance of the central nervous system among resuscitated men.

In view of these results, we may now consider it the task of the medical man to give active treatment for agonal and clinical death. With the cessation of cardiac and respiratory action, we cannot end our struggle for the life of the patient, especially in cases of sudden death. From this moment, the struggle becomes more intense, but not hopeless. The heart that has stopped beating can in a certain number of cases be started again, although the task is not an easy one. Respiration may also be restored, although this is even more difficult. That restoration of the functions of the whole organism follows in a certain number of cases is now an established fact. Our present task is to convert the occasional and often empirical treatment of agonal and clinical death into scientifically based and—more important—systematic therapy of these states.

V. NEGOVSKY.

Moscow.
Oct. 24 (by cable).

ANTI-TADPOLE SERA

By Dr. A. S. PARKES, F.R.S.

National Institute for Medical Research, Hampstead, London, N.W.3

EXPERIMENTS on the antigenic properties of iodinated proteins prompted the question of whether tadpoles could be passively immunized by adding antiserum to the surrounding medium. While investigating this problem, certain experiments were carried out with anti-tadpole serum prepared by injecting tadpole extracts into rabbits and tested by adding to water containing tadpoles. The results were reminiscent of those obtained by Oliver-González[1] with antiserum to parasitic worms.

Preparation of extracts and antisera. The tadpoles, which were fed on raw liver or dried liver powder, were starved for some days before extraction. The first extracts were made merely by weighing the tadpoles, grinding them with sand and a total of three volumes of saline, and centrifuging. These extracts, however, contained a large quantity of minute particles. Later extracts were therefore centrifuged, frozen at −10° C., and recentrifuged. The freezing coagulated the suspended material, which was removed by the second centrifuging, and a much cleaner preparation resulted. Attempts at Seitz filtration resulted in loss of practically all the protein material, and the extracts were freeze-dried for storage. The rabbits were immunized by intermittent injections of 5 c.c. of the extracts, given intraperitoneally or intravenously. Samples of serum were obtained at various times up to five months after the first injection. In view of the extremely heterogeneous nature of the extracts the samples may well have differed qualitatively at different stages of immunization.

Method of test. Antisera were prepared against tadpoles of three different species of Anura, *Xenopus laevis*, *Discoglossus pictus* and *Rana temporaria*. Tests were carried out mainly on *Xenopus* tadpoles, the technique being to put tadpoles, usually twenty, into a 250 c.c. beaker containing 200 c.c. of medium composed of a small amount of original tank water, tap water, and varying amounts of normal or antiserum. Observations were made up to a maximum of forty-eight hours.

Results. The results described below, except where otherwise stated, relate only to anti-*Xenopus* rabbit serum tested on *Xenopus* tadpoles.

Normal rabbit serum up to 1 : 25 is tolerated comparatively well by *Xenopus* and *Discoglossus* tadpoles. The concentration used in the experiments was not generally above 1 : 50. With this concentration of normal serum there is no obvious change in either tadpoles or medium at room temperature during the first twelve hours. During the second twelve hours, and particularly during the second day, the medium becomes progressively more turbid and the tadpoles, which dislike turbid water, become progressively less at ease; nevertheless, in six consecutive experiments deaths among the controls in 1 : 50 normal serum were less than 1 per cent in forty-eight hours. The development of the turbidity can be prevented by the addition of sodium sulphathiazole (1/1,000) and is undoubtedly due to bacterial growth. Bacteria are part of the normal food of *Xenopus* tadpoles, and the rate at which turbidity develops is dependent to some extent on the size and vigour of the tadpoles.

The addition to the medium of serum from rabbits injected with tadpole extract leads to unmistakably different results. A concentration of 1 : 50 of a good antiserum quickly kills all the tadpoles. This reaction is greatly affected by a number of variables, of which the most important seem to be the freshness of the serum and the age of the tadpole. A medium which kills seven-day tadpoles in less than three hours may take four or six hours to kill those a few days older, and twenty-four hours or more to kill those of twenty-eight days. With a 1 : 50 concentration of a poor antiserum, or with lesser concentrations of a good antiserum, the survival period of even the small tadpoles may be extended to twelve hours, twenty-four hours, or indefinitely. The immediate cause of death has not been determined, but interference with the respiratory mechanism may be involved. Tadpoles which survive in antiserum for more than a few hours often acquire a fringe on the tail fin; under binoculars, clumps of small particles can be seen adhering to the margin and particularly to the end of the tail (Fig. 1). This phenomenon, which has not been observed when only normal serum is present, is presumably due to agglutination between the tadpoles and particles of tadpole origin present in the medium, or else to adherence of precipitate from the medium. It is possible that death of the tadpoles during the second twenty-four hours has a cause different from that of death in the early phases. The following observations and conclusions are based on results obtained during the first eight hours of experiment on young tadpoles:

a b

Fig. 1. (*a*) *Xenopus* TADPOLE EIGHT DAYS OLD AFTER TWENTY-FOUR HOURS IN 1/100 NORMAL RABBIT SERUM; (*b*) TADPOLE OF THE SAME BATCH AFTER TWENTY-FOUR HOURS IN 1/100 ANTISERUM. SIXTEEN OF THE GROUP OF TWENTY HAD ALREADY DIED.

(*a*) Time-response and dose-response relations for one of the better samples of antiserum tested on seven-day tadpoles at room temperature (about 22° C.) are shown in Figs. 2 and 3.

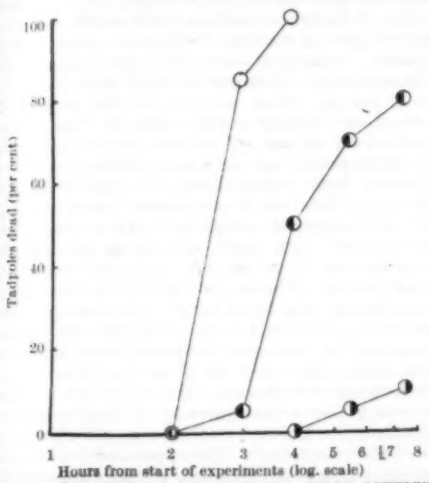

Fig. 2. TIME-RESPONSE RELATIONS FOR THREE DIFFERENT CONCENTRATIONS OF ANTISERUM. TWENTY TADPOLES, SEVEN DAYS OLD, PER GROUP. 22° C. THERE WERE NO DEATHS IN THE CONTROL GROUP RECEIVING NORMAL SERUM.
● = 1 : 200 anti-tadpole serum.
◐ = 1 : 100 " "
○ = 1 : 50 " "

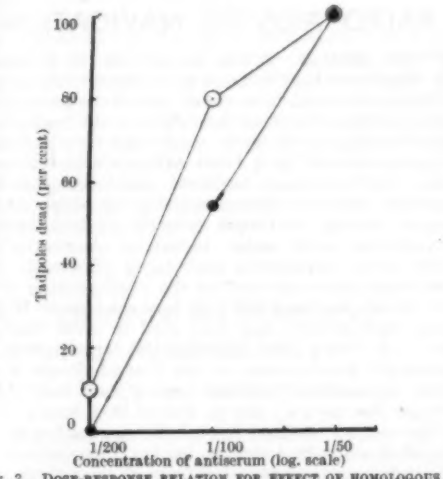

Fig. 3. DOSE-RESPONSE RELATION FOR EFFECT OF HOMOLOGOUS ANTISERUM ON *Xenopus* TADPOLES. TWENTY TADPOLES PER GROUP. 22° C.
○ = 8 hours.
● = 4 hours.

(*b*) The antiserum is inactivated by the addition of tadpole extract, and under appropriate conditions a precipitin reaction can be demonstrated. It is likely, therefore, that a real immunological reaction is involved in the death of the tadpoles.

(*c*) Antiserum heated to 55° C. for 15 min. loses most of its activity. The activity is wholly or partly restored by the addition of fresh normal rabbit serum. It is possible, therefore, that exogenous complement plays some part in the reaction. This idea is supported by the fact that the antiserum loses activity on Seitz filtration and on storage in the wet state, and that the activity thus lost is partly restored by addition of fresh normal rabbit serum. The residual activity of heated and stored extracts, which mainly cause death only during the second day, may depend on some reaction not involving the labile factor.

(*d*) With antisera of reduced activity the reaction occurs more readily when twenty tadpoles are present in the 200 c.c. of medium than when there are only five. This may be connected with the observation that the medium tends to become more turbid when it contains antiserum than when it contains normal serum, and that this turbidity, unlike that associated with the presence of normal serum, is not wholly suppressed by the addition of sodium sulphathiazole (1/1,000). It is probable that the turbidity seen with antiserum is augmented by precipitation of products of tadpole origin present in the medium.

Preliminary observations on species specificity suggest that antiserum to either *Xenopus* or *Discoglossus* tadpoles is more effective against homologous than against heterologous tadpoles, but there is obviously considerable overlap which is also shown by the fact that antiserum to *Rana temporaria* tadpoles is effective to some extent against *Xenopus* tadpoles.

I am most grateful to several of my colleagues at the Institute for guidance and criticism.

[1] Oliver-González, J., *J. Infect. Dis.*, **67**, 292 (1940).

OCEAN WAVES AND SWELL

THE Challenger Society at its meeting on January 23 heard a paper on "Ocean Waves and Swell" by Dr. G. E. R. Deacon, including, by permission of the Director of Scientific Research, Admiralty, an account of war-time research.

After a brief account of earlier work on the development and growth of waves, Dr. Deacon indicated the nature of the technique by which the Admiralty Swell Forecasting Section, composed of United States and British officers, made reliable predictions of waves and swell from meteorological data and forecasts.

This was followed by a description of new methods of measuring waves, by which continuous recordings can be obtained in exposed sites, a mile or more from the coast, using instruments lying on the sea bottom and connected to recording stations by submarine cables. One type of recorder measures the pressure fluctuations below the waves, and the other, an inverted echo-sounder, records an echo-profile of the surface.

The improved methods of recording have emphasized the importance of interference between waves of different lengths, and after detailed observations in the summer of 1944, it was decided that no fundamental advance could be made until a method had been developed of resolving a complex wave record in sufficient detail to allow the amplitude of each wave-length present to be measured. A special analyser developed for the purpose, almost automatic in operation, allows a 20-minute wave record to be analysed with more than sufficient detail in about ten minutes.

Routine frequency analyses have been made of records taken every two hours of the waves and swell in the neighbourhood of Land's End since February

1945. One advantage of the analysis is that it allows the immediate detection of the low long swell which travels fastest and is the first to arrive from a distant storm area. This is probably never possible by visual observation of the waves or records, because the long swell is obscured by short waves. An example showed the detection of swell, which when it first arrived was only a few inches high, with a period of 24 sec., from a depression 500 miles south-east of Newfoundland. It is hoped to make frequency analyses of waves in mid-Atlantic, for comparison with the subsequent analysis of the resulting swell in Cornwall, before the summer.

Most of the recent work described was done by the Oceanographical Group at the Admiralty Research Laboratory, Teddington. The paper will be published as the first number of a new series, the "Occasional Papers of the Challenger Society".

The Committee of the Challenger Society wishes to direct attention to its publication "The Science of the Sea", described in its sub-title as the Society's "Elementary Handbook of Practical Oceanography for Travellers, Sailors and Yachtsmen" (Clarendon Press, Oxford). This standard work was revised and published under the editorship of the late Dr. E. J. Allen of Plymouth in 1928, and a recent marked increase of sales of the book in the United States is thought to reflect a growing American interest in oceanography, particularly in the Pacific. Since the opportunity of producing a new edition is not likely to offer itself for some time to come and the study of the sea is of prime importance to countries of the British Commonwealth, the attention of British oceanographers, professional and amateur, is directed to this work before the stock is exhausted. The sub-title quoted above may suggest that the work is intended more particularly for amateurs, but it is of equal value to professional marine biologists. It includes chapters on the air, the water, and the sea floor, which give the physical background to other sections on plant and animal life in the varied habitats afforded by the sea. The methods of collecting, the equipment necessary, and the means of preserving and recording catches are also described.

GENETICS AND TAXONOMY IN INDIA

DURING the last fifteen years geneticists have been displaying an increasing interest in the problems of wild populations—with, in fact, the problems of the systematist, the ecologist and the student of evolution. The results of this activity, which are familiar from many publications, bear ample testimony to the power of genetical methods and ideas in this joint field. In taking "Genetics, Taxonomy and Ecology" as the subject of his presidential address, delivered in February 1944 to the Indian Society of Genetics and Plant Breeding (*Indian J. Genetics*, **4**, 2; 1944), Dr. W. Burns has therefore been concerned less to justify such work than to consider the opportunities afforded for it by the plants of India.

Dr. Burns addresses himself especially to plant breeders, whose training in the perception of fine differences and in the genetical manipulation of cultivated plants should also enable them to add much to our knowledge of wild ones. While recognizing the value of adequate herbaria in aiding identification, and incidentally regretting the paucity of such facilities in India, Burns emphasizes the essential need for observing the wild plant in its natural habitat, supplemented by the experimental garden. Turning to the material which India offers, he cites many examples of natural variation which might well repay further study. A number of these are cases of polymorphism, a phenomenon studied less in plants than in animals so far; but attention is also directed to cases of foreign weeds introduced into India. The centres, directions and rates of spread of these weeds are unknown, as are the natures of the changes in their genotypes which have occurred in response to, and which have fitted them for, their new living conditions. Nor are the agencies determining the limits and changes in distribution of any of the native plants known with much certainty, though these can sometimes be related to geological boundaries. A combination of botanical surveying with systematic, genetical and cytological work, paying special attention to clines and to the behaviour of plants at the margins of their distribution, is needed for the better understanding of all these questions.

With the growth of active interest in such problems, it is well to have the attention of Indian botanists and geneticists directed to the scope afforded by the flora of their own land. The opportunities offered to them are second to none, and, if these opportunities are taken, we may be confident that the outcome will be confined in value neither to India nor to wild plants.

K. MATHER.

RADIO AIDS TO NAVIGATION

THE meeting of the Institution of Electrical Engineers held in London on January 26 marked a historic occasion in so far as part of the proceedings took the form of a joint meeting with the Institute of Radio Engineers in New York, the two audiences being connected by a trans-Atlantic radiotelephone link. The American Institute was holding its first post-war winter technical meeting, at which several papers dealing with such subjects as broadcasting, navigational aids, radar, industrial electronics and radio wave propagation were being presented. The particular paper selected for the joint meeting of the two bodies was entitled "An Introduction to Hyperbolic Navigation", and was read in New York by Mr. J. A. Pierce, who has played a large part in the successful development in the United States of the radio navigational system known as *Loran* (LOng RAnge Navigation) [see p. 152 of this issue].

The author defined hyperbolic navigation as the use of synchronized signals, having a known velocity of propagation, transmitted from at least three fixed points, and the measurement of the relative times of arrival at a receiving point, the position of which it is required to determine. If a navigator receives simultaneously signals from two such fixed and synchronized stations, he knows that his position is somewhere along the perpendicular bisector of the line joining the transmitting stations. If one signal arrives before the other, a measurement of the time-difference identifies some other line of position on which the navigator must be. These lines of position are approximately spherical hyperbolæ.

This hyperbolic principle is at present used in at least four existing systems. Two of these use pulse-modulated signals: the *Loran* system referred to

above, and the *Gee* system developed and applied so successfully in Britain for aerial navigation over Europe and the precision bombing of enemy targets. Of the other two systems, both developed in Britain, one uses continuous wave technique and is known as the Decca Navigator system (see *Nature*, Nov. 3, 1945, p. 542); while the other, operating on somewhat similar principles, uses modulated continuous waves and has been developed by engineers of the British Post Office.

Reverting to Mr. Pierce's paper, the standard *Loran* system was developed primarily for over-water navigation, and thus operates on medium frequencies between 1,700 and 2,000 kc./s. The modulating pulses are some 50 micro-seconds in duration, and the signals from several stations may be interspersed in the same radio-frequency channel. The time-difference between signals arriving at a receiver can be measured to an accuracy of 1 micro-second or less, corresponding to a distance of 300 metres. With transmitters radiating about 100 kW., a reliable ground-wave range over sea-water of about 700 nautical miles is achieved; at this and greater distances, however, the accuracy of observation deteriorates due to the reception of both ground and ionospheric waves. In these circumstances the total error has an average value of about 8 μ-sec. for a single reading; the corresponding minimum average error of position-fix is rather less than one nautical mile. Later developments include the use of lower radio frequencies to extend the ground-wave range, and the improvement of accuracy by comparing the phases of the radio-frequency oscillations within the pulse-modulation envelopes.

After the presentation of the paper by Mr. Pierce, the presidents of the two institutions exchanged cordial greetings, and expressed the wish that this might be the forerunner of a series of such meetings. The chairman of the Radio Section of the London Institution then commented on some technical points in the paper presented, and the author replied to these from New York. The radio link between the two meetings was then disconnected, and the London meeting proceeded with a more detailed technical discussion of Mr. Pierce's paper.

JOHANN PHARAMUND RHUMELIUS

By Dr. M. NIERENSTEIN

SOME years ago I spent several days at Everglades in Florida botanizing in the Cypress Swamps, visiting some of the Thousand Islands, the two Seminole Indian Reserves and the ruins of Sam Jones' Old Town. While at Everglades, I bought a copy of the "Opuscula Chemico-Magico-Medica" (Noremburgæ, 1635) by Rhumelius, described by Ferguson[1]. From Everglades, I went to Moore Haven on Lake Okeechobee and from there to Okeechobee itself, a small town where I made the acquaintance of a farmer who told me that he had an old medical book, bought several years ago at Baton Rouge in Louisiana. It proved, on examination, to be the same book by Rhumelius, and I therefore asked my American friend for the address of the bookseller at Baton Rouge.

On my arrival at Baton Rouge I was offered a copy of the "Medicina Spagyrica" (Noremburgæ, 1657), also described by Ferguson, which I declined; but I bought two rare works by Rhumelius, namely, the "Bibliotheca ophthalmica", 2 vols. (Argentoratæ, 1648), and the "Die Schliessung aller Hurhäuser in Nürnberg" (Strassburg, 1637).

According to Ferguson[1], Rhumelius was the younger son of Johann Conrad Rhumelius, and lived between 1574 and 1630. He settled in general practice at Neumark[2], but had to leave as he was a Roman Catholic and went to Nuremberg, where he died[3]. As the "Bibliotheca ophthalmica" is prefaced February 17, 1648, he was obviously alive in 1648. He was, however, still alive in 1657, since among his letters given to me by my friend the bookseller at Baton Rouge I found two letters addressed to his cousin Conrad Rhumelius, dated 1657.

Many years later, when I was at San-Juan-de-los-Morros in Venezuela, I saw a copy of the "Opuscula" (Temixtitanæ, 1703), the original name of Mexico[4]. In this edition all the magical and alchemical parts had been removed, and a list of South American therapeutically useful plants inserted[5].

Both the "Opuscula" and the "Medicina Spagyrica" are written in German and as vulgar as any work of Paracelsus. They deal with the usual pharmaceutical and medical topics of the time. Both these works are fairly common and they do not require further analysis.

The title "Bibliotheca ophthalmica"[6] is misleading, as it is a well-reasoned history of ophthalmology one never sees mentioned[7]. As regards the "Schliessung aller Hurhauser in Nürnberg" the methods of closing these institutions proposed by Rhumelius are drastic, but well in keeping with the time he lived in. He explains in the preface that, as councillor of the city of Nuremberg, he had attempted in council to stamp out vice, but all his attempts were in vain, since the city derived too good an income from licences granted to keepers of brothels. That he is strongly of the opinion that it is his duty to bring matters to a head, and he is therefore publishing his book in Strasbourg as he feels certain that Nuremberg would suppress publication. The methods suggested by him are frequent raids, branding men and women found in brothels, and imprisonment for brothel owners—a year for every year they had been licensed. He remarked: "there is a hag in Nuremberg who has had a licence for 26 years and she will have plenty of time in prison to think and brood over the harm she has done to mankind".

Although drastic, Rhumelius's recommendations were not as severe as those that had from time to time been in force against brothel keepers and prostitutes[8], especially prostitutes suffering from venereal diseases[9].

[1] Ferguson, "Bibliotheca Chemica", 2 vols. (Glasgow, 1906).
[2] Jöcher, "Allgemeines Gelehrten-Lexicon", 4 vols. (Leipzig, 1750–51).
[3] Gerding, "Geschichte der Chemie" (Leipzig, 1869). Meyer, "Geschichte der Chemie" (Leipzig, 1895). Ferguson, *loc. cit.* Hiordahl, "Fremstilling a Kemica Historie", 2 vols. (Christiana, 1906).
[4] Prescott, "History of the Conquest of Mexico" (London, 1878). There was also an 1843 Philadelphia edition which I have not seen.
[5] Some of the plants inserted in this edition are still listed in the "Farmacopea Mexicana" (Mexico, 1925).
[6] The "Catalogus Librorum . . ." of W. M. Enter's Library (1695). Noremburgæ lists a copy of the "Bibliotheca ophthalmica", 1677, also printed in Strassburg.
[7] Neither Sorsby's "A Short History of Ophthalmology" (1945), London, nor some of the larger works listed by him (pp. 93–94) I have had the opportunity to consult, mention the "Bibliotheca ophthalmica" by Rhumelius.
[8] Wrede, "Die Körperstrafen bei allen Völkern von den ältestin Zeiten bis auf die Gegenwart" (Dresden, 1898).
[9] Dufour, "Histoire de la prostitution chez tous les peuples du monde", 6 vols. (Paris: 1851–1854).

FORTHCOMING EVENTS

Saturday, February 9

BRITISH PSYCHOLOGICAL SOCIETY (at University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. J. F. Wilson: "The Reality of being Blind"; Mr. Eric Farmer: "Certain Aspects of the Social Adjustment of the Blind".

Tuesday, February 12

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, The University, Birmingham), at 4 p.m.—Prof. A. R. Todd, F.R.S.: "Synthesis in the Study of Nucleotides" (Pedler Lecture).

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers and Exhibits.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. Hartridge, F.R.S.: "Some Recent Advances in the Physiology of Vision".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Rev. Peter B. G. Binnall: "Anthropology and Adult Education".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. H. S. Allpress: "The Design and Performance of Industrial Lighting".

Wednesday, February 13

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. F. W. Shotton: "Geological Work in the Invasion of North-West Europe".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Prof. F. H. Garner: "Petroleum in Wartime" (Presidential Address).

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. G. Brazier: "Joints, Sealing Ends and Accessories for Pressure Cable".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 5.30 p.m.—Prof. G. I. Finch, F.R.S.: "A Scientific Approach to Fire Fighting and Prevention" (Fothergill Lecture).

ROYAL METEOROLOGICAL SOCIETY (joint meeting with the SCOTTISH CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS, at the Heriot-Watt College, Edinburgh), at 6 p.m.—Discussion on "Weather and Electric Power Systems" (to be opened by Mr. J. S. Forrest and Mr. A. J. Drummond).

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at Gas Industries House, 1 Grosvenor Place, London, S.W.1), at 6.30 p.m.—Mr. R. E. Threlfall: "Glass Tubing".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the FOOD GROUP and the PLASTICS GROUP, at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Dr. G. L. Riddell: "Science and Packaging" (Jubilee Memorial Lecture).

INSTITUTE OF WELDING, SHEFFIELD BRANCH (at the Royal Victoria Station Hotel, Sheffield), at 7 p.m.—Dr. Paterson: "Welding Metals and Plastics".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "Science in the British Commonwealth" (Speakers: Prof. A. V. Hill, F.R.S., Prof. M. L. Oliphant, F.R.S., Prof. C. S. Hanes, F.R.S., and Prof. J. D. Bernal, F.R.S.).

Thursday, February 14

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. James Gray, F.R.S.: "Life in the Sea".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the INSTALLATIONS and MEASUREMENTS SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. A. J. King: "The Analysis of Vibration Problems".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. A. R. Dunton: "Plastics".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Prof. G. A. H. Buttle: "War Experiences in Therapeutics".

ASSOCIATION OF SCIENTIFIC WORKERS, BIRKBECK COLLEGE BRANCH (at Birkbeck College, Bream's Buildings, Fetter Lane, London, E.C.4), at 8 p.m.—Prof. M. L. Oliphant, F.R.S.: "Atomic Energy".

Friday, February 15

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Imperial Chemical Industries, Ltd., Billingham, Co. Durham), at 4 p.m.—Dr. A. E. J. Vickers: "Photography Applied to Physico-chemical Research".

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. G. O. Jones: "The Physical and Rheological Properties of Glass" (members of the Optical Group are invited).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. E. C. Bullard, F.R.S.: "The Protection of Ships from Magnetic Mines".

CHEMICAL SOCIETY (in the large Lecture Theatre, Chemistry Department, The University, Glasgow), at 5.30 p.m.—Dr. W. A. Waters: "Some Recent Developments in the Chemistry of Free Radicals" (Tilden Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. T. E. Beacham: "High-Pressure Gear Pumps".

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, SCIENTIFIC AND TECHNICAL GROUP (joint meeting with the COLOUR GROUP, at 16 Princes Gate, London, S.W.7), at 6 p.m.—Mr. L. C. Jesty: "Colour Television".

BRITISH ASSOCIATION OF CHEMISTS, NOTTS. AND DERBY SECTION (at the School of Art, Green Lane, Derby), at 7 p.m.—Dr. H. O'Neill: "The Relation of Atomic Structure to Hardness Properties of Metals and Alloys".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Large Physics Theatre, The University, Oxford Road, Manchester), at 7 p.m.—Dr. W. S. Stiles: "Vision at Low Intensities of Illumination".

Saturday, February 16

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Discussion on "Amino Sugars and Uronic Acids in Nature".

Friday, February 15—Sunday, February 17

ASSOCIATION OF SCIENTIFIC WORKERS, in co-operation with the ASSOCIATION OF UNIVERSITY TEACHERS, the INSTITUTE OF PROFESSIONAL CIVIL SERVANTS and the BRITISH ASSOCIATION OF CHEMISTS (at the Beaver Hall, Garlick Hill, London, E.C.4).—Conference on "Science and the Welfare of Mankind".

Friday, February 15

At 7 p.m.—"Science and World Needs" (Speakers: Representative Foreign Scientists, Mr. Herbert Morrison, P.C., M.P., Prof. P. M. S. Blackett, F.R.S.).

Saturday, February 16

At 2.30 p.m.—"The Implications of Recent Scientific Development" (Speakers: Prof. M. L. Oliphant, F.R.S., on "Atomic Energy", Prof. Sir Alfred Egerton, F.R.S., on "Chemical Engineering", Dr. H. L. Richardson on "Agriculture").

Sunday, February 17

At 10 a.m.—"The Responsibilities of Scientists in Modern Society" (Speakers: Prof. B. Farrington, Prof. J. D. Bernal, F.R.S., Mr. Arthur Horner).

At 2.30 p.m.—"The Organisation of Science" (Speakers: Dr. Julian Huxley, F.R.S., on "The International Organisation of Science", Prof. P. M. S. Blackett, F.R.S., on "The National Organisation of Science").

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN AGRICULTURE with special qualifications in ANIMAL HUSBANDRY—The Registrar, The University, Leeds (February 16).

LECTURER (full-time) IN THE MECHANICAL ENGINEERING DEPARTMENT of the Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (February 16).

HEAD OF THE ENGINEERING DEPARTMENT—The Principal, Technical College, Hopwood Lane, Halifax (February 16).

LECTURER IN THE ENGINEERING DEPARTMENT—The Registrar, North Gloucestershire Technical College, Cheltenham (February 18).

ASSISTANT LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Manchester 13 (February 22).

LECTURERS (2) IN THE DEPARTMENT OF MECHANICAL AND MARINE ENGINEERING of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (February 23).

WATERWORKS ENGINEER by the Baghdad District Water Board, Iraq—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting E.77/OA (February 25).

TEACHER (full-time) of ENGINEERING SUBJECTS—The Principal, Municipal College, Leigh, Lancs. (February 25).

MYCOLOGIST (Ref. No. F.5128.A), and a BOTANIST (Ref. No. F.5353.A), to undertake research on problems relating to the cultivation of *Hevea brasiliensis* for the Rubber Research Scheme, Ceylon—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (February 28).

WATER ENGINEER to the Local Health Commission, Natal—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting E.30.OA (March 6).

UNIVERSITY CHAIR OF CHEMISTRY tenable at the Royal Holloway College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 8).

UNIVERSITY CHAIR OF CIVIL ENGINEERING tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 21).

UNIVERSITY CHAIR OF MECHANICAL ENGINEERING tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 27).

PROFESSOR OF EXPERIMENTAL PATHOLOGY AND DIRECTOR OF CANCER RESEARCH in the Newcastle Division of the University of Durham (King's College)—The Registrar, University Office, 23 St. Thomas' Street, Newcastle-upon-Tyne 1 (March 30).

CHAIR OF ZOOLOGY—The Registrar, University College, Southampton (March 31).

SENIOR LABORATORY TECHNICIAN for the DEPARTMENT OF ANATOMY—The Registrar, King's College, Newcastle-upon-Tyne.

Responsible TEACHER in charge of the ENGINEERING DEPARTMENT of the Burton-upon-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-upon-Trent.

LECTURER (full-time) IN MECHANICAL ENGINEERING—The Principal, Erith Technical College, Erith Road, Belvedere, Kent.

AGRICULTURAL CHEMIST, and an AGRICULTURAL BOTANIST AND ZOOLOGIST—The Secretary and Bursar, Seale-Hayne Agricultural College, Newton Abbot, Devon.